



# TURBIDITY SENSOR 4296

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# INTRODUCTION

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## Purpose and Scope

With this document, we will give the reader knowledge on how to operate, calibrate and maintain the Aanderaa Turbidity Sensor 4296. It also aims to give insight on how the Turbidity sensor works. We cover all sensor versions in one single manual since the operation and configuration is identical. The main difference is calibration range and depth rating.

The sensor is used either as part of a system or stand-alone. Chapter 2 to 5 covers different ways to connect and operate the sensor. Since each chapter describes the full operation you only need to read one of these chapters.

Optical Turbidity sensors for ocean and freshwater applications have been available for many years from different vendors. The Aanderaa smart sensor family are known for the proven long-term stability (years) and reliability and used in applications ranging from streams to the deepest oceanic trenches on earth, from fish farms to wastewater, from polar ice to hydrothermal vents.

With the release of Framework 3 in 2011, Aanderaa introduced a new firmware version to accommodate higher security and future expansion. Both the Smart Sensor Terminal protocol and the AADI Real Time protocol was updated with this version of the Smart Sensor firmware.

Aanderaa Smart Sensors utilize communication protocols at the RS-232 interface where the Smart Sensor Terminal protocol is a simple ASCII command string-based protocol and the AADI Real Time is an XML based protocol.

Turbidity Sensor 4296 fits directly on the SeaGuard top-end plate and is interfaced by means of a reliable CAN bus interface (AiCaP), using XML for plug and play capabilities. The sensor can also be used as stand-alone sensor with RS-232 output. The sensor is available in three different depth ratings, 300-meter, 3000-meter and 6000-meter.

Please note that the sensors need to be mounted without any obstruction in front of the sensors to avoid reflection or blocked signal. With low Turbidity concentrations you need longer distance to any reflecting objects to avoid disturbance.

## Document Overview

Chapter 1 is a description of each sensor covered by this manual with pin configuration and properties.

Chapter 2 is a description of how to configure the sensor when connected to a SeaGuard with display

Chapter 3 is a description of how to configure a stand-alone sensor using AADI Real-Time Collector

Chapter 4 describes how to configure the sensor using SeaGuard without display, SeaGuardII or SmartGuard.

Chapter 5 describes how to configure and operate a stand-alone sensor using Terminal software.

Chapter 6 describes how to log data using AADI Real-Time Collector.

Chapter 7 describes maintenance need and recommendations

Chapter 8 describes the principle behind the Turbidity Sensor.

Chapter 9 describes Electromagnetic Combability.

Chapter 10 contains examples of all documents and available cables.

## Applicable Documents

	Assembly Drawing 4296
	Sensor Cable 3855, Sensor to PC, RS-232 for laboratory use
	Sensor Cable 4865, Sensor to PC, RS-232 for field use
	Sensor Cable 4762, Sensor to free end
	Sensor Cable 4793 for remote sensors used on SeaGuard
	Patch Cable 4999 for direct connection
	Sensor Cable 5236 for connection to SmartGuard
Form 992	Test & Specification Sheet for Turbidity Sensor
Form 726	Calibration Certificate Temperature
Form 993	Calibration Certificate for Turbidity Sensor
D 424	Data sheet for Turbidity Sensor 4296

## Abbreviations

<b>ADC</b>	Analogue to Digital Converter
<b>AiCaP</b>	Automated idle line CAN bus Protocol, a modified communication protocol developed by Aanderaa for a distributed network of smart sensors when connected to SeaGuard, SeaGuardII or SmartGuard loggers.
<b>ASCII</b>	American Standard Code for Information Interchange
<b>DSP</b>	Digital Signal Processor
<b>FNU</b>	Formazin Nephelometric Units
<b>FTU</b>	Formazin Turbidity Unit
<b>NTU</b>	Nephelometric Turbidity Units
<b>LED</b>	Light Emitting Diode
<b>MSB</b>	Most significant bit
<b>UART</b>	Universal Asynchronous Receiver/Transmitter
<b>RTC</b>	Real Time Clock
<b>TSS</b>	Total Suspended Solids

# CHAPTER 1 Short Description and Specifications

---

## 1.1 Description

The Aanderaa Turbidity Sensor 4296 are measuring optical backscatter in water. Turbidity is the optical property of the water that causes light to be scattered by suspended particles. High particle concentration causes high turbidity. By establishing the relationship between turbidity and the local suspended matter this measurement can be used for assessing the concentration of suspended matter.

The Turbidity Sensor 4296 measures the backscatter of infrared light. A high efficiency light emitting diode is used to transmit modulated light into the water. The backscattered light is picked up by a sensitive photodiode and this signal is then conditioned, linearized and converted to data in engineering unit (FTU). In addition to turbidity, the sensor also measures water temperature.

An FTU calibrated sensor will not be directly comparable to a NTU or FNU sensor since they are only identical when measuring in Formazin. The measurement principle is different for the three methods. For all other liquids except Formazin they will be different and there is no direct correlation between the three methods.

The sensor is measuring approximately 35mm away from the sensor but also objects close to this point may influence the reading. This means that you should always try to mount the sensor with free view.

## 1.2 Sensor versions available

The sensor is available with four different ranges:

4296	0-25	FTU
4296A	0-125	FTU
4296B	0-500	FTU
4296C	0-2500	FTU



### 1.2.1 Turbidity Sensor 4296

Turbidity Sensor is encapsulated in a Titanium housing and are available in three depth ratings 300-meter, 3000-meter and 6000-meter. The sensor is designed for use on SeaGuard platforms but may also be used on cable. Standard version has AiCaP and RS-232 output. Please note that the lemo plug used for this sensor are not a 1 to 1 plug. This means that e.g. pin 1 on sensor are connected to pin 8 on cable.

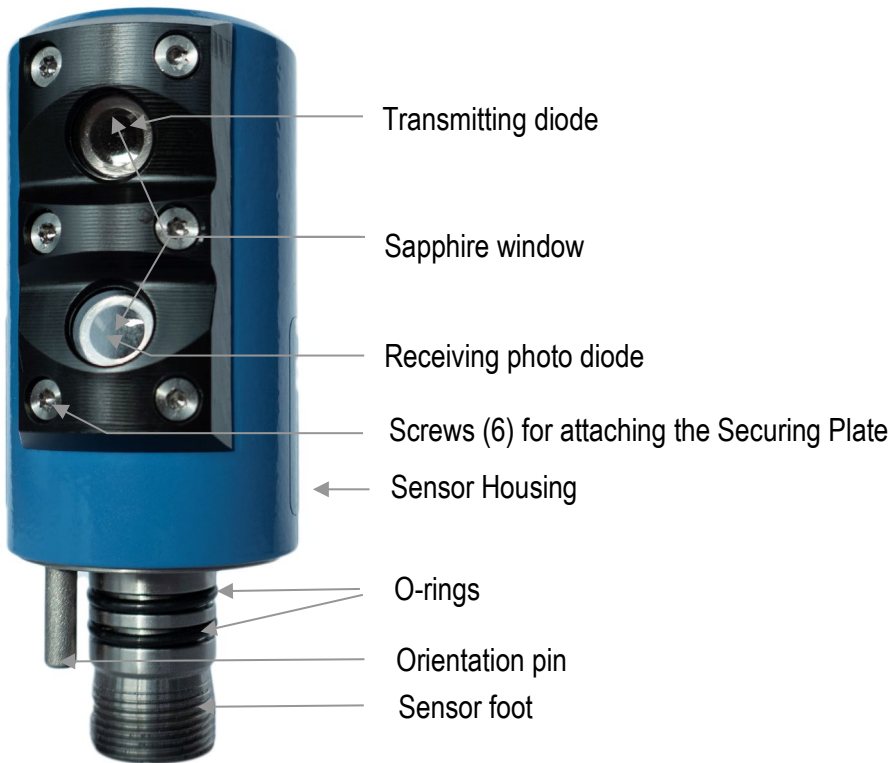


Figure 1-1 Illustration of the Turbidity Sensor 4296.

#### PIN CONFIGURATION

Receptacle, exterior view;

pin = ● bushing = ○

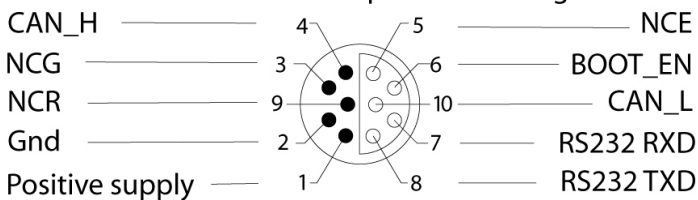


Figure 1-2: Turbidity Sensor 4296 Pin Configuration

### 1.3 Cross section with physical dimensions

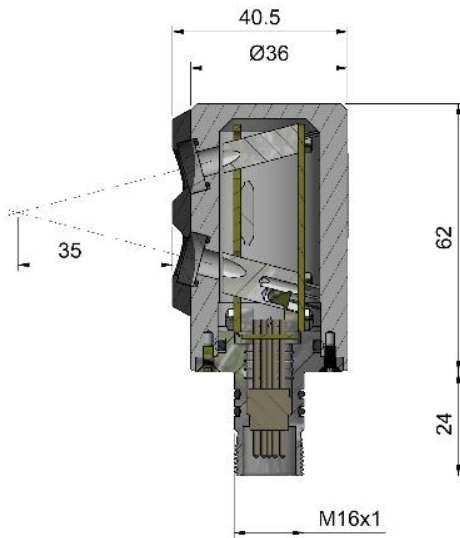


Figure 1-3: Turbidity sensor cross section

### 1.4 Pin Configuration

The Turbidity Sensor 4296 pin configuration is given in [Figure 1-2](#) above. A description of the receptacle notation is given in [Table 1-1](#).

Table 1-1 Description of the Pin Configuration

Signal	Description
CAN_H	CAN bus line (dominant high)
NCG	Node Communication Ground
NCR	Node Communication Request
Gnd	Ground
Positive supply / V+	5-14V positive supply
NCE	Node Communication Enable
BOOT_EN / Boot Enable	Boot Load Enable (do not connect)
CAN_L	CAN bus line (dominant low)
RS232 RXD / RXD	RS232 Receive line
RS232 TXD / TXD	RS232 Transmit line

### 1.4.1 Lemo plug connection

The 4296 sensors are using a lemo plug. This plug is not a 1 to 1 plug like e.g. Subconn. See **Table 1-2** for a complete list of connections between sensor and cable plug or hub card plug.

**Table 1-2: Lemo plug Pin Configuration**

Signal	Sensor pin	Cable pin
Positive supply / V+	1	8
Gnd	2	7
NCG	3	6
CAN_H	4	5
NCE	5	4
BOOT_EN / Boot Enable	6	3
RS232 RXD / RXD	7	2
RS232 TXD / TXD	8	1
NCR	9	10
CAN_L	10	9

## 1.5 Sensor Connection

Aanderaa offers a wide range of cables for different use of the sensors, both standard cables using AiCaP or RS-232 but also special customer specified cables for use in project. See **chapter 9.6** for an overview of standard cables or contact [aanderaa.sales@xylem.com](mailto:aanderaa.sales@xylem.com) for more info. To configure the sensor, it needs to be connected to an Aanderaa logger using AiCaP, a real-time RS-232 cable or a RS-232 configuration cable.

### 1.5.1 Configure sensor using RS-232 configuration cable

Connect your sensor to one of the COM ports on your PC. If your PC comes without serial ports (COM ports) you may also use an USB to Serial Adapter. We then recommend the Tripp-lite Keyspan Model USA -19HS

The 3855 cable is a non-watertight 1.5-meter cable for laboratory use only used for connection between sensor and PC in the office/lab. This is a standard cable that can also be used to configure most other Aanderaa Smart Sensors as well.

The cable is supplied with a USB port providing power to the sensor from the PC USB port. A USB extension cable is supplied with the cable so alternatively you may connect the free end to an external power (6-14V). An alternative solution is *to use a 9V alkaline battery (6LF22) to set the sensor up or log it in the laboratory.* Sensor Cable 3855 is also available in other lengths.

### 1.5.2 Configuration Cable 3855

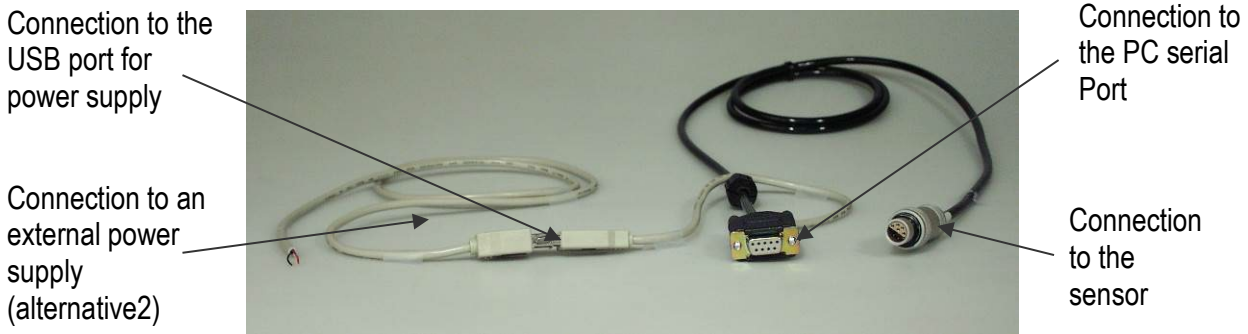


Figure 1-4: Set-up and configuration cable 3855

Table 1-3: Cable 3855 pin configuration

Signal name	Sensor plug	9-p D-Sub	USB
TXD	1	2	
RXD	2	3	
Boot Enable	3		
BV	4		4 (black)
GND	7	5	1 (red)
Positive Supply	8		
RTS short to CTS		7-8	

### 1.6 Using PC without COM-port



If your PC comes without a COM-port we recommend to use a USB to serial converter.

*Figure 1-5* shows one alternative, Keyspan USA-19HS.

Connect the USB plug to your PC USB-port and then your sensor to the 9pin DSub.

Figure 1-5: Serial to USB converter

## 1.7 User accessible sensor properties

All configuration settings that determine the behavior of the sensor are called properties and are stored in a persistent memory block (flash). One property can contain several data elements of equal type (Boolean, character, integer etc.). The different properties also have different access levels.

To read the value of a certain properties you need to send ASCII string starting with the command **get** and then followed by the property name to the sensor, see example below.

To change the content of a property you need to send an ASCII string starting with **set** and then followed by the property name and new value in brackets to the sensor.

### Get Interval

//When sending this string to the sensor, it will then return the value stored in this property.

**Interval 4296 39 60.000**

//Returned from sensor, where 4296 is the product number, 39 is the serial number of the sensor and 60 is the value stored as interval. To change the value you might send the following command:

### Set Interval(30) Save

//This will change the value for this property to 30 seconds  
//Always end with save to store setting in flash

The interval will now be changed to 30 seconds. For more details, see **CHAPTER 6**

## 1.8 Passkey for write protection

Table 1-4: Passkey protection

Output	Passkey	Description
No		No Passkey needed for changing property
Low	1	The Passkey must be set to 1 prior to changing property
High	1000	The Passkey must be set to 1000 prior to changing property This Passkey value also gives read access to factory properties that usually are hidden
Read Only	Factory	The user has only read access

To avoid accidental change, most of the properties are write-protected. There are four levels of access protection, refer **Table 1-4** .

A special property called **Passkey** must be set according to the protection level before changing the value of properties that are write-protected, refer **Table 1-4**. After a period of inactivity at the serial input, the access level will revert to default. This period corresponds to the **Comm TimeOut** setting, or 1 minutes if the **Comm TimeOut** is set to **Always On**.

## 1.9 Sensor Properties

When using AADI Real-Time Collector you do not need to think about the command string sent to the sensor since this is fully controlled by the software.

Some properties of the 'AiCaP' sensor will not be applicable / visible when the sensor is connected to a SeaGuard, SeaGuardII or SmartGuard Datalogger, as the instrument will control these properties.

All sensor properties are listed in **chapters 1.8.1** through **1.8.4**.

### 1.9.1 Factory Configuration

All properties in this section are Read Only, not possible to overwrite for the user. Only certified Aanderaa service personal can alter these settings. The access level for reading the status of this properties is however different for each property, see table for more details. In this group we find information about Software and hardware settings, Production, Service and Calibration dates.

**Table 1-5: Factory Configuration; Sensor Properties for Turbidity Sensor 4296.**

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Category	Access Protection Read/Write
<i>Product Name</i>	String	31	Aanderaa Product name	FC	No/ Read Only
<i>Product Number</i>	String	6	Aanderaa Product number		
<i>Serial Number</i>	INT	1	Serial Number		
<i>SW ID</i>	String	11	Software Identifier		
<i>SW Version</i>	INT	3	Software version (Major, Minor, Built)		
<i>HW ID X</i>	String	19	Hardware Identifier, X=1..3		High/ Read Only
<i>HW Version X</i>	String	9	Hardware Identifier, X=1..3		
<i>System Control</i>	INT	3	For internal use		
<i>Production Date</i>	String	31	AADI Production Date, format YYYY-MM-DD		
<i>Last Service</i>	String	31	Last service date, format YYYY-MM-DD, empty by default		
<i>Last Calibration</i>	String	31	Last calibration date, format YYYY-MM-DD		No/ Low
<i>Calibration Interval</i>	INT	1	Recommended Calibration Interval in Days		
<i>C2Range</i>	INT	1	Selecting the range. Range setting: 1=0-25FTU, 2=0-125FTU, 3=0-500FTU and 4=0-2500FTU		

## 1.9.2 Deployment Settings

Deployment Settings contains settings for instruments metadata like position and owner, but also site dependent properties storing data that might influence the measurement.

**Table 1-6: Deployment Settings; Sensor Properties for Turbidity Sensor 4296.**

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Category	Access Protection Read/Write
<i>Interval</i>	Float	1	Sampling Interval in seconds	DS	No/No
<i>Location</i>	String	31	Set the location		
<i>Geographic Position</i>	String	31	Set the geographic position		
<i>Vertical Position</i>	Float	1	User value for describing sensor position		
<i>Reference</i>	String	31	User setting for describing sensor reference, user definable.		

### 1.9.3 System Configuration

This group contains properties used to set the mode, for parameter enabling and controlling the output from sensor.

Table 1-7 Part 1 of 2: System Configuration; Sensor Properties for Turbidity Sensor 4296.

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Category	Access Protection Read/Write
<i>Mode</i>	ENUM	1	Operation Mode: AiCaP, Smart Sensor Terminal, AADI Real-Time, Smart Sensor Terminal FW2	SC	No/ Low
<i>Enable Sleep</i>	BOOL	1	Enable sleep mode		
<i>Enable Polled Mode</i>	BOOL	1	Enable Polled Mode (for RS232), when set to 'no' the sensor will sample at the interval given by the <i>Interval</i> property, when set to 'yes' the sensor will wait for the 'Do Sample' command.		
<i>Enable Text</i>	BOOL	1	Enable text, when set to 'no' the startup info and the parameter text is removed		
<i>Enable Decimalformat</i>	BOOL	1	Controls the use of decimal format in the output string		
<i>Enable Rawdata</i>	BOOL	1	Controls inclusion of raw data in the output string		
<i>Enable Temperature</i>	BOOL	1	Controls inclusion of Temperature in the output		
<i>Enable TSS</i>	BOOL	1	Controls inclusion of calculated TSS in the output		



### 1.9.4 User Maintenance

This group mainly contains sensor settings that normally not altered by the user. To access most of these properties you need to send **set passkey(1000)** or with Real-Time Collector use password: **1000**. These properties will configure serial port settings, communication to and from sensor, temperature and range coefficients for each calibration range. It also contains properties used to calculate TSS and to set the interval for the Transmitter Level reference diode.

**Table 1-8 Part 1 of 2: User Maintenance; ; Sensor Properties for Turbidity Sensor 4296. ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')**

Property	Type	No of elements	Use	Category	Access Protection Read/Write
<i>Node Description</i>	String	31	User text for describing node, placement etc.	UM	No/ Low
<i>Owner</i>	String	31	User setting for owners name	UM	No/ High
<i>Baudrate</i>	ENUM	1	RS232 baudrate: 300,1200,2400,4800,9600,57600,115200 <sup>1)</sup>	UM	High/ High
<i>Flow Control</i>	ENUM	1	RS232 flow control: None or Xon/Xoff		
<i>Enable Comm Indicator</i>	BOOL	1	Enable the Communication Sleep ('%') and Communication Ready ('!') indicators		
<i>Comm TimeOut</i>	ENUM	1	RS232 communication activation timeout: Always On,10 s,20 s,30 s,1 min,2 min,5 min,10 min		
<i>TempCoef</i>	Float	6	Curve fitting coefficients for the temperature measurements.	UM	Low/ High
<i>C1R1Coef</i>	Float	6	Curve fitting coefficients Range 1: 0-25FTU		
<i>C1R2Coef</i>	Float	6	Curve fitting coefficients Range 2: 0-125FTU		
<i>C1R3Coef</i>	Float	6	Curve fitting coefficients Range 3: 0-500FTU		
<i>C1R4Coeff</i>	Float	6	Curve fitting coefficients Range 4: 0-2500FTU	UM	High/ Read Only
<i>C2R1Coef</i>	Float	6	Factory use only		
<i>TSSCoef</i>	Float	6	Coefficients used to calculate TSS based on local samples	UM	Low/ High
<i>TXReference Interval</i>	INT	1	Transmit Level Reference use to compensate for drift in optics.		

## 1.10 Sensor parameters

Engineering data calculated by firmware in the sensor (Sensor Firmware) based on measured raw data and sets of calibration coefficients stored in the sensor:

- Turbidity content presented in FTU (Formazin Turbidity Unit). Conversion to other commonly used units is only possible when measuring in Formazin.
- TSS(Total Suspended Solids is presented in mg/l
- The ambient Temperature presented in °C.
- TXCAmp() is presented in mV

The Turbidity raw data are the phase and amplitude of the returned signal after the

C1Amp(mV):           Amplitude measurement with  
C2Amp (mV):        Amplitude measurement with  
RawTemp(mV):      Voltage from Thermistor Bridge.

To enable these parameters select **Enable Rawdata(Yes)**.

Calibration coefficients are stored in the sensors flash and updated when recalibrated. If raw data are not needed the user can select to turn off the delivery and logging of these.

## 1.11 Sensor integrated firmware

The main tasks for the sensor-integrated firmware are to control the transmitter, sample the returned signal, extract the phase of this signal, and convert it into Turbidity.

All settings that are changeable for each individual sensor, e.g. calibration coefficients are called sensor properties. The properties can be displayed and changed via RS-232 using AADI Real-Time Collector or a terminal communication program. If connected to an Aanderaa it can also be configured via an AiCaP bus.

The Turbidity Sensor will perform a measurement sample and present the result within the first 1.5 seconds after the sensor power up.

## 1.12 Specifications

For product specifications refer Datasheet D424 on our web site <http://www.aanderaa.com> or contact [aanderaa.info@xylem.com](mailto:aanderaa.info@xylem.com)

You will always find the latest versions of our documentation on the web.

On our website, you will also find the latest version of product manuals, technical notes and software. Please contact [aanderaa.info@xylem.com](mailto:aanderaa.info@xylem.com) for guidance.

## 1.13 Manufacturing and Quality Control

Aanderaa Data Instruments products have a record for proven reliability. With over 50 years' experience producing instruments for user in demanding environments around the globe; you can count on our reputation of delivering the most reliable products available.

We are an ISO 9001, ISO 14001 and OHSAS 18001 Certified Manufacturer. As a company, we follow three underlying principles: quality, service, and commitment. We take these principles seriously, as they form the foundation upon which we provide lasting value to our customers.

## CHAPTER 2 Configuration on SeaGuard with display

The 4296 Turbidity sensor is equipped with a CAN bus interface supporting AADI AiCaP (Automated idle line CAN bus Protocol). This standard ensures easy plug and play connection to all Aanderaa SeaGuard, SeaGuardII and SmartGuard data logger. Make sure the sensor is set to AiCaP mode before you connect the sensor to the AiCaP bus. Default setting from factory is AiCaP.

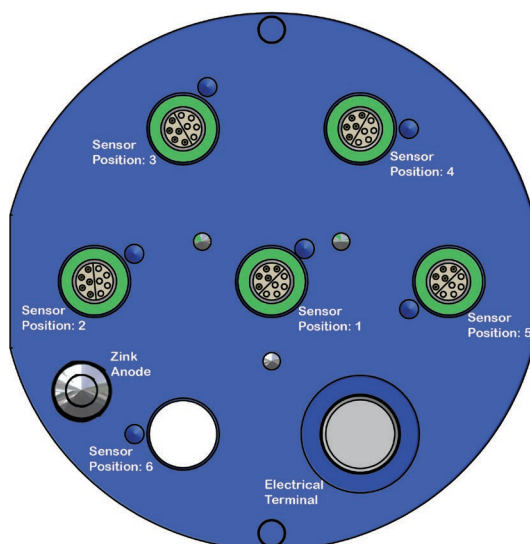
When connected to an AiCaP bus network the sensor will report its capabilities and specifications to the data logger at power up. The data logger assembles the information and provides the user with the possibility to configure the instrument based on the presented nodes. This solution provides for greater flexibility on both use and design of the different elements within the system.

Note! This chapter describes the configuration of the Turbidity Sensor 4296 when connected to a SeaGuard with display. Refer TD262a for a thorough description of how to configure the SeaGuard Instrument, and to perform Node Identification and Recorder settings.

For configuration on SeaGuardII or SmartGuard, see **CHAPTER 4**.

### 2.1 Installation on SEAGUARD® Platform

The Turbidity Sensor 4296 designed for use with AADI SeaGuard data loggers fits directly on the top-end plate or used with a cable. Before connecting the sensor always turn off the power. We recommend that you install the Turbidity Sensor in sensor position 3, 4 or 6, refer **Figure 2-1**. If mounted in position 6, use patch cable to connect the sensor to the HUB card.



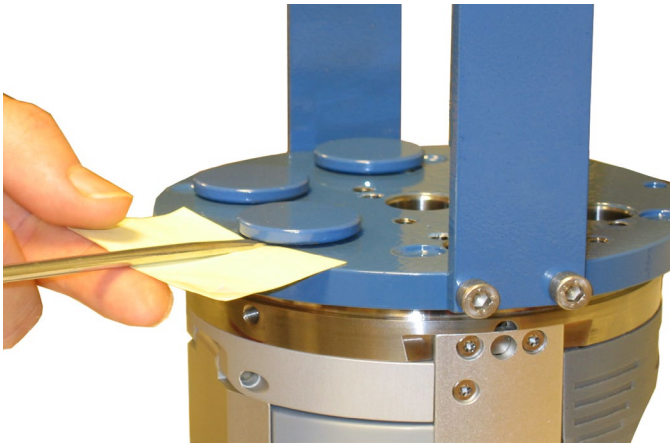
*Refer SeaGuard Platform Operating Manual, TD262a, for an illustrated sensor installation guide. TN309 holds an extract of sensor connection / disconnection given in the SeaGuard Operating Manual.*

*Note!*

*Always replace O-rings when removing, exchanging, or installing a new sensor or a sealing plug.*

Figure 2-1: SeaGuard Top-end plate

All sensor and sealing plugs except for the center position are secured by means of a setscrew in the side of the top end plate. Start by unscrewing the setscrew for the wanted position (the setscrew will stop when sufficiently extracted). Pull out the sealing plug (or sensor) by inserting a screwdriver in the slot between the plug and the top end plate, see **Figure 2-2**.



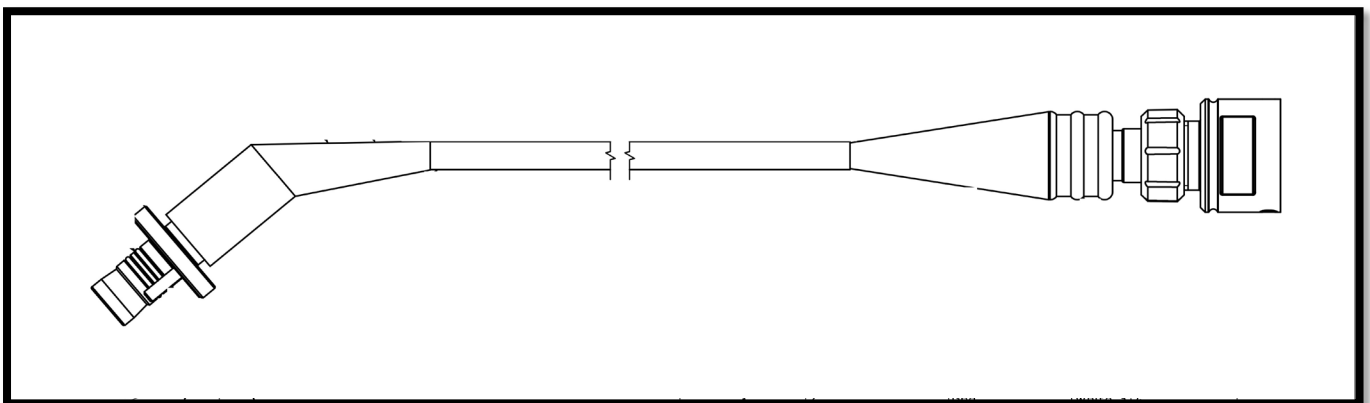
**Figure 2-2: Removal of sealing plug.**

Use a small piece of paper/cardboard to protect the lacquer of the top-end plate. Make sure that the surface in the hole is clean and smooth and check that the O-rings at the sensor foot are free from dust and particles and greased with silicon grease. Align the orientation pin in the sensor foot with the orientation hole in the top end plate, and carefully insert the sensor. When fully seated at the top end plate, tighten the setscrew with only moderate force.

Note! Always replace O-rings when connecting a sensor or a sealing plug.

## 2.2 Sensor Cable for remote sensor

Sensor Cable 4793 is used for remote sensor connection on SeaGuard for example if you want to measure gradients. Instrument side fits directly on the top-end plate using the same connection as a standard AiCaP sensor.



**Figure 2-3: Remote sensor cable 4973**

## 2.3 Sensor Configuration

In this section, we will show you how to configure the sensor connected to a SeaGuard with display. If you have a SeaGuard without display or a SeaGuardII please proceed to **CHAPTER 4**. We will only cover the sections that are special for the turbidity sensor. Some of the screenshots might be different on your logger due to different setup and accessories connected. Some of the screenshots used are from other sensors but are then identical except from the sensor name.



Figure 2-4: Select Menu to start

After installing the sensor in one of the sensor positions turn power on and open menu by pressing the **Menu** button in the lower left corner. Four submenus contain properties for the Turbidity sensor.

- **Administrative Tools**
- **Sensor Identification**
- **System Configuration**
- **Deployment Settings**

These menus are covered in this chapter. For information about the other menus, see *SeaGuard Platform Operating Manual, TD262a*.

To enable/disable a parameter, change a value or change a text:

Select the output parameter from the list, press **View/Edit** or **Edit Description** in the lower part of the window, and change the setting by ticking the box or use the keyboard sign in lower left corner to type a new value or text, press **Ok** and **Save/Finish** to save and then close the window to finish the update.

### 2.3.1 Administrative Tools

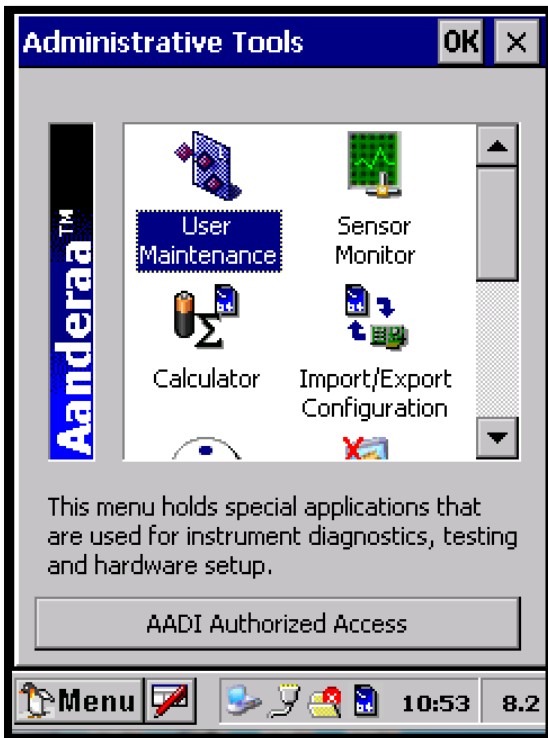


Figure 2-5: Administrative Tools

Open **Administrative Tools** from the **Menu**.

This section contains more submenus. In chapter **2.3.5** we will cover **User Maintenance** and in chapter **7.1.1** we will cover the **Sensor Monitor menu**.

For all other submenus, please refer to *SeaGuard Platform Operating Manual, TD262a*.

### 2.3.2 Sensor Identification

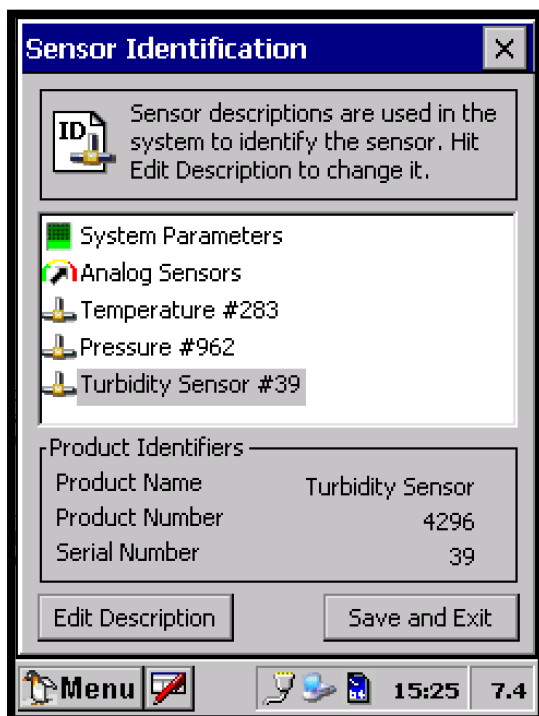


Figure 2-6: Sensor Identification

Open **Sensor Identification** from the main **Menu**.

**Sensor Identification** is a list of all sensor connected to the logger. You may also change the description, using the **Edit Description** button, but the default will be **'Sensor Name' # 'Serial Number'**

When you select one of the sensors, you will find **Product Name**, **Product Number** and **Serial Number** in the **Product Identifier** section.

### 2.3.3 System Configuration



Figure 2-7: System Configuration menu

Open **System Configuration** from the main **Menu**. Under **System Configuration** you will find two tabs.

- **Instrument**
- **Sensors**

For more information about the Instrument tab and its submenus, see **SeaGuard Platform Operating Manual, TD262a**.

Select the **Sensors** tab to continue.

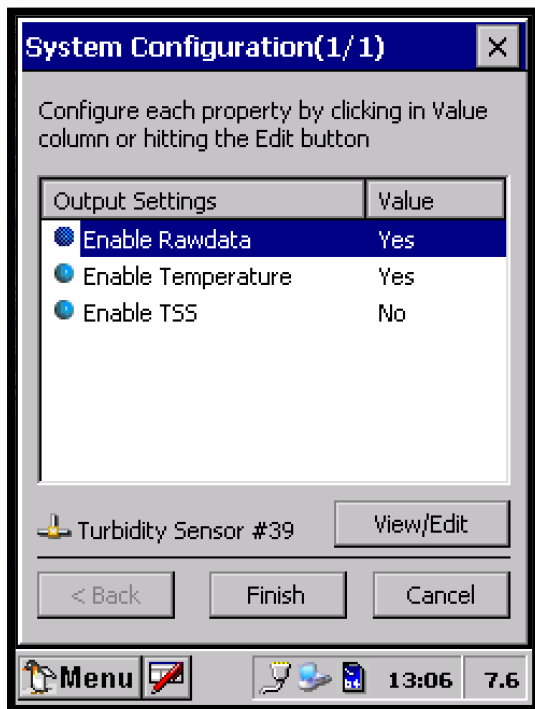


Figure 2-8: System Configuration Sensors selection

The **System Configuration** sensor tab holds a list of all Analog and AiCaP sensors connected to the logger. Select the newly installed **Turbidity Sensor** that should appear in the list of sensors, and tap **Configure** in the lower part of the window.

Alternatively, if you want to configure all sensors in the list you may select the **Run Wizard** button that will run you through all the individual sensor configurations.





The **System Configuration** for the **Turbidity Sensor** holds a list of output parameters that can be **enabled/disabled** by the user. Enabled properties (**Yes**) are calculated and sent to the data logger:

- **Enable Rawdata**, refer chapter 1.9
- **Enable Temperature** in Deg. C.
- **Enable TSS**, enables the calculation of **TSS** based on the coefficients stored in **TSSCoef**. See **chapter 8.1** for more info about this measurement.

We recommend that you enable all parameters in case of later use. The storage capacity on the SD-card is normally not a limitation for the SeaGuard. Raw data can be used to control calibration coefficients and perform quality control on the data.

Figure 2-9: System Configuration parameter enabling

## 2.3.4 Deployment Settings



Figure 2-10: Deployment Settings menu

Open **Deployment Settings** from the main **Menu**. In **Deployment Settings** you will find two tabs.

- **Instrument**
- **Sensors**

For more information about the Instrument tab and its submenus, see **SeaGuard Platform Operating Manual, TD262a**.

Select the **Sensors** tab to continue.



Figure 2-11: Deployment Settings Sensor selection

The **Sensors** tab holds a list of all Analog and AiCaP sensors connected to the logger. Select the newly installed **Turbidity Sensor** that should appear in the list of sensors, and tap **Configure** in the lower part of the window.

Alternatively, if you want to configure all sensors in the list you may select the **Run Wizard** button that will run you through all the individual sensor configurations.

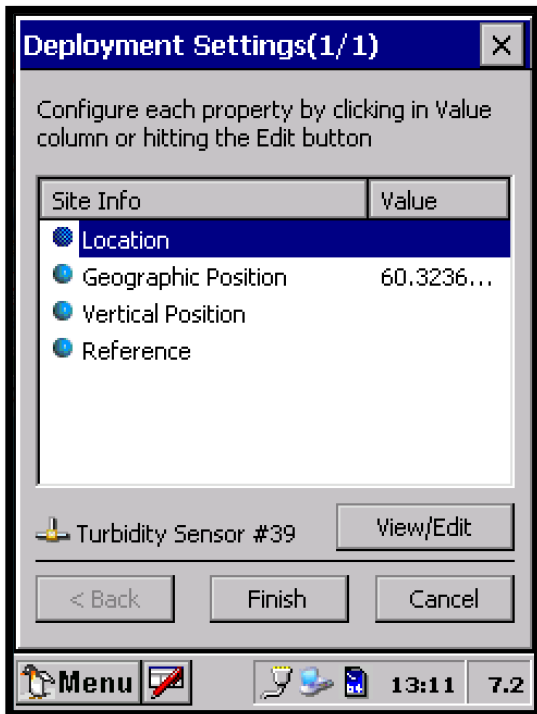


Figure 2-12: Deployment Settings properties

The **Deployment Settings** for the **Turbidity Sensor** hold a list of user defined inputs:

- **Location**
- **Geographic Position**
- **Vertical Position**
- **Reference.**

The values of these settings are not used in any calculations. To add information to one of these properties, select the property, press **View/Edit** and with the keyboard panel enter the text or numbers. Press **OK** and **Finish** storing the information.

## 2.3.5 User Maintenance



Figure 2-13: Administrative Tools

Special property settings and calibration coefficients are found in **User Maintenance**.

**User Maintenance** is a submenu under the **Administrative Tools** menu.

Open **Administrative Tools** from the **Menu** button  
Select **User Maintenance**.



Figure 2-14: User Maintenance menu

In **User Maintenance** you will find two tabs.

- **Instrument**
- **Sensors**

For more information about the Instrument tab and its submenus, see **SeaGuard Platform Operating Manual, TD262a**.

Select the **Sensors** tab to continue.



Figure 2-15: User Maintenance Sensors tab

The **User Maintenance** sensors tab holds a list of all Analog and AiCaP sensors connected to the logger. Select the newly installed **Turbidity Sensor** that should appear in the list of sensors, and tap **Configure** in the lower part of the window.

Alternatively, if you want to configure all sensors in the list you may select the **Run Wizard** button that will run you through all the individual sensor configurations.



Figure 2-16: User Maintenance password menu

In **User Maintenance** you find properties that are password protected and are set/alterd by the 'advanced user', **note! The password is 1000**. Enter the password using the keyboard activated in the lower left corner and the press **OK** to access. The properties in **User Maintenance** are normally not changed during normal operation.

The user maintenance holds four submenus:

- **Mandatory**
- **Site Info**
- **Calibration**
- **Sample Settings**

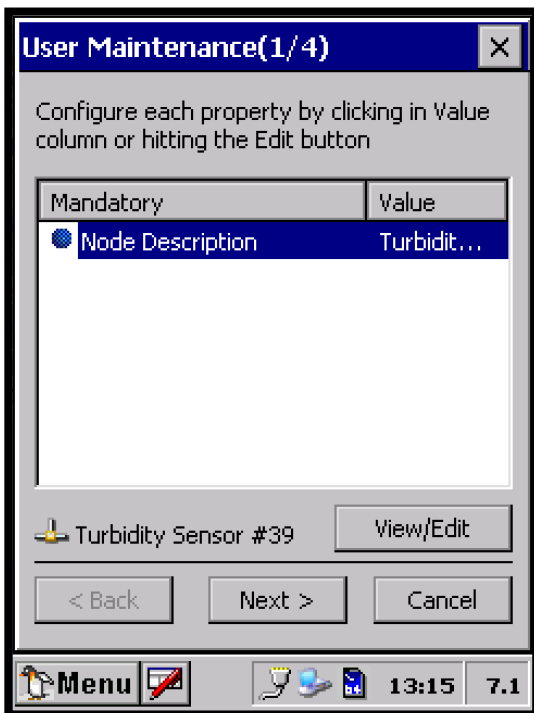


Figure 2-17: Mandatory

First submenu is the **Mandatory**. Select the **Node Description** property, press **View/Edit** in the lower part of the window, if you want to change the value. Press **Save** to store the setting when completed.

**Node Description** is a user entered text describing the sensor, placement etc. If using for example a SeaGuard sensor string with multiple sensors connected; renaming the sensor can facilitate analyzing data. The text is by default set to the product name followed by product number and serial number, e.g. **Turbidity Sensor 4296#39**.

Press **Next>** to continue with the next submenu.

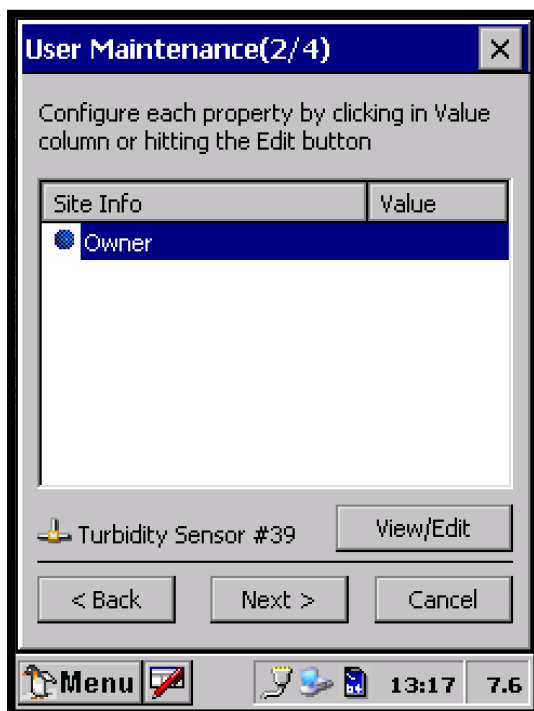


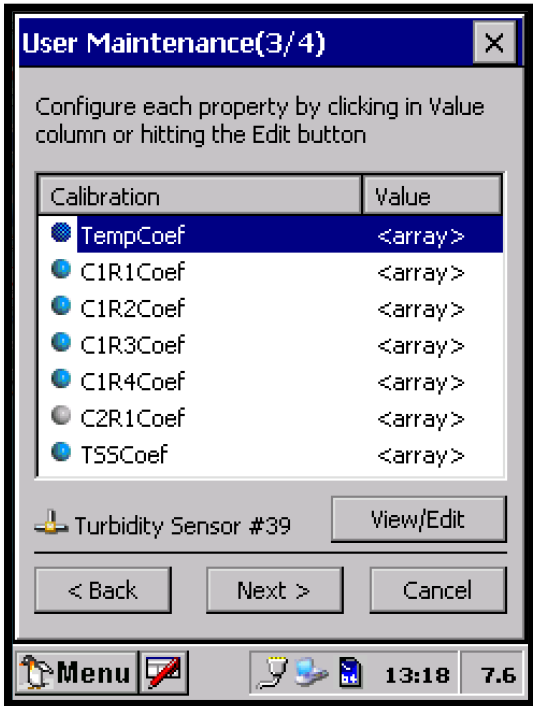
Figure 2-18: Site Info

The second submenu in the **Turbidity User Maintenance** is **Site Info** and holds a setting for **Owner**.

This property is not used by the sensor and therefore optional. Typical value here is Name and contact info for **Owner**.

Select the **Owner** property, tap **View/Edit** and type your value. Press **Save** to store the setting.

Press **Next>** to continue with the next submenu.



The third submenu are **Calibration**. For each calibration property to be set first select the property then press **View/Edit** and type the correct value. Press **Save** to store the settings.

Except from the **TSSCoef** all coefficients in this group should not be changed unless you are instructed by a certified Aanderaa representative.

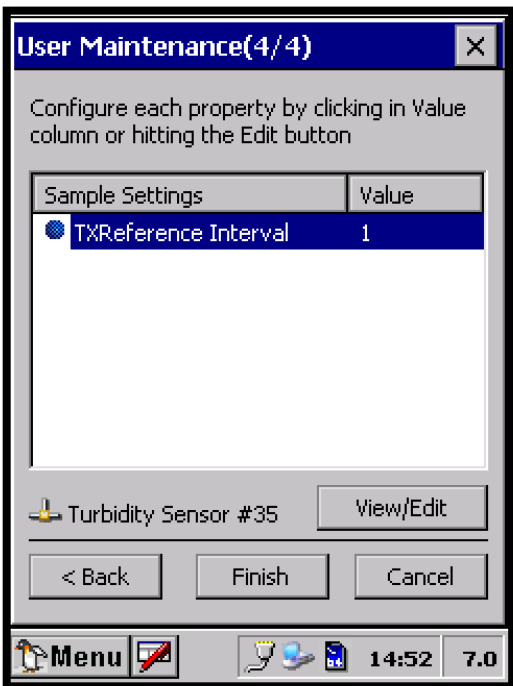
**TempCoef** is calculated after a temperature calibration performed at the factory.

**C1R1Coef, C1R2Coef, C1R3Coef** and **C1R4Coef** is calculated after calibration at factory for each of the four ranges. **C2R1Coef** is only for factory use and therefore write protected.

**TSSCoef** are used to convert the sensor reading to **TSS** based on local samples collected and filtered. See **chapter 8.1** for more info.

Press **Next >** to continue with the next submenu.

Figure 2-19: Calibration Coefficients



The last submenu in the **Turbidity Sensor User Maintenance** is **Sample Settings** and holds settings for:

**TXReference Interval**; this is a sample interval divisor for use of **TXReference**. When the value is set to **1** (default) the **TXReference** measurement is performed during each sample. The value can be increased to reduce power drain or to set a faster sampling interval, less than **2 sec**. When the value is set to e.g. **10**, the **TXReference** measurement is only performed for each 10<sup>th</sup> sample.

Figure 2-20: Sample Settings

## CHAPTER 3 Stand-alone Sensor configuration using Real-Time Collector

This chapter describes the stand-alone sensor configuration using AADI Real-Time Collector when the sensor is used as stand-alone sensor with serial communication RS-232. The menus shown here are slightly different from the menus shown when the sensor is working in AiCaP mode and configured through an Aanderaa Datalogger (described in **CHAPTER 4**).

It's also possible to use terminal software to configure a stand-alone sensor, refer **CHAPTER 6**, but then you need to enter all the commands and send them to the sensor. With Real-Time Collector it's much easier since the software will then let you configure the sensor using the available choices in each category.

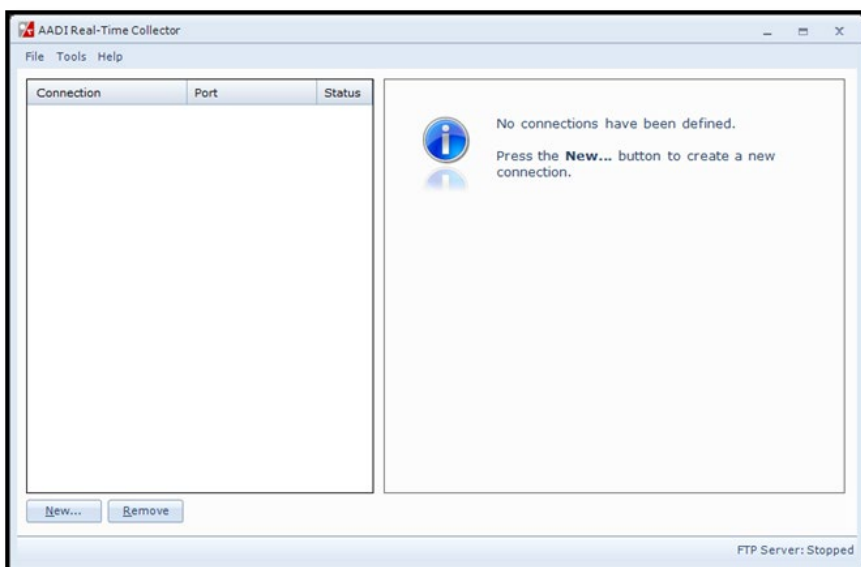
Before connecting the sensor to your computer, you need to install and start the AADI Real-Time Collector software on your PC.

For more information about the AADI Real-Time Collector, refer TD 268 AADI Real-Time Collector Operating Manual. See **chapter 1.5** for more information about sensor connection.

### 3.1 Establishing a new connection

If this is the first time you start the software the connection list will be empty. You can then either generate a new general connection that can be used for different sensor with the same output protocol as a general Aanderaa Smart Sensor connection. However, you can also generate a special connection for one specific sensor like **Turbidity Sensor 4296 #12**

#### 3.1.1 Add new connection to the list



The first time you open the **AADI Real-Time Collector** program, the connection list will be empty.

Click on the **New** button in the lower left corner to create a new connection.

**NOTE:** You only need to do this once. **AADI Real-Time Collector** will keep the information for later use and next time you might select it from the connection list.

Figure 3-1: AADI Real-Time Collector start up menu



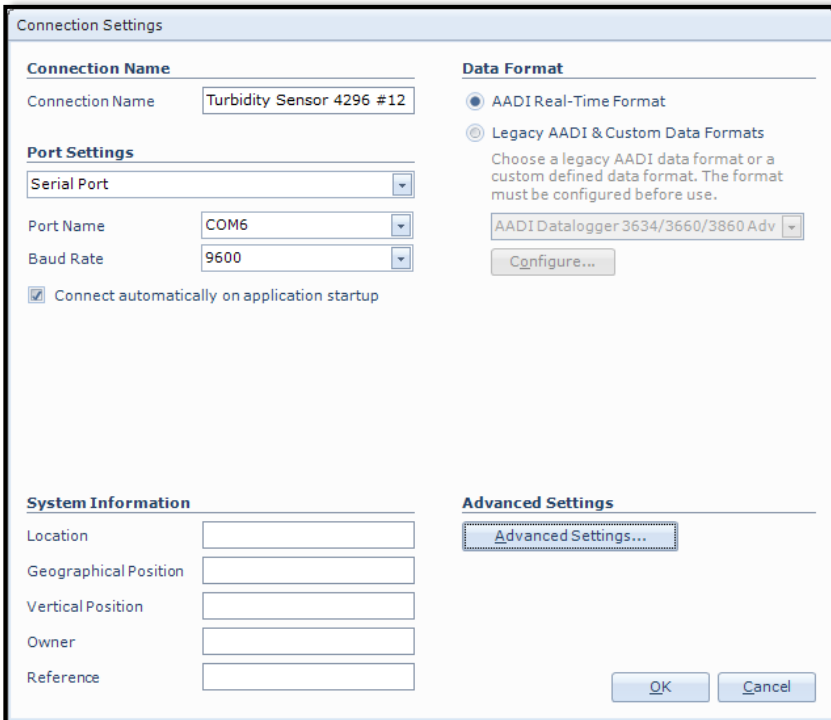


Figure 3-2: AADI Real Time Collector connection settings

First enter a new **Connection Name**, we recommend using name and serial number or just the type of sensor if you want to use the same connection for multiple sensors.

Select **Serial Port** in the dropdown menu under **Port Setting** and choose the correct COM-port on your computer under **Port Name**. COM-port number may vary depending on your connections.

Select **9600** as **Baud Rate**. This is the default baud rate on all Turbidity Sensors.

The **Baud Rate** needs to match the baud rate set in **User Maintenance**.

### 3.1.2 Establish contact with the sensor

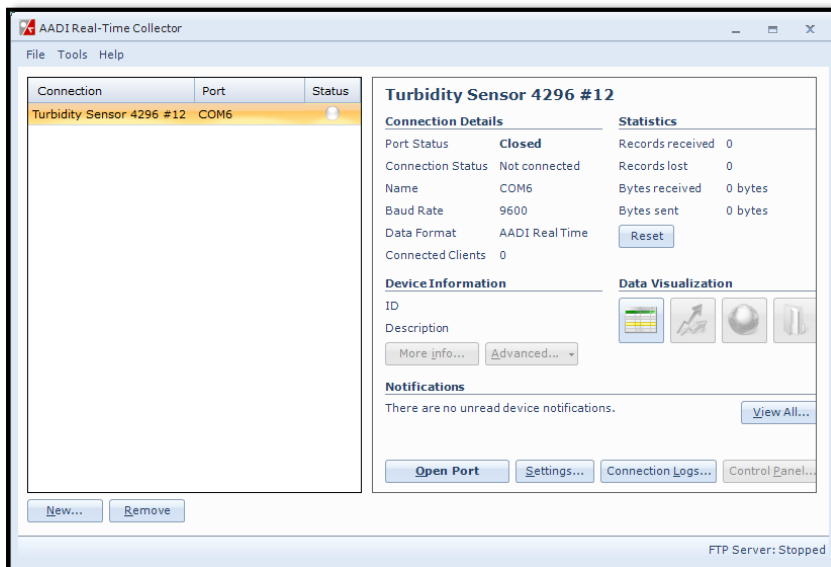


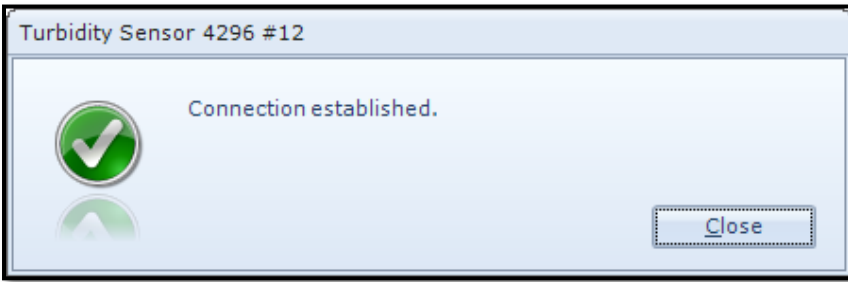
Figure 3-3: New connection

The new connection will then be available in the **AADI Real-Time Collector** connection list.

Click on the line with the new connection to highlight this connection and then click on the **Open Port** button.

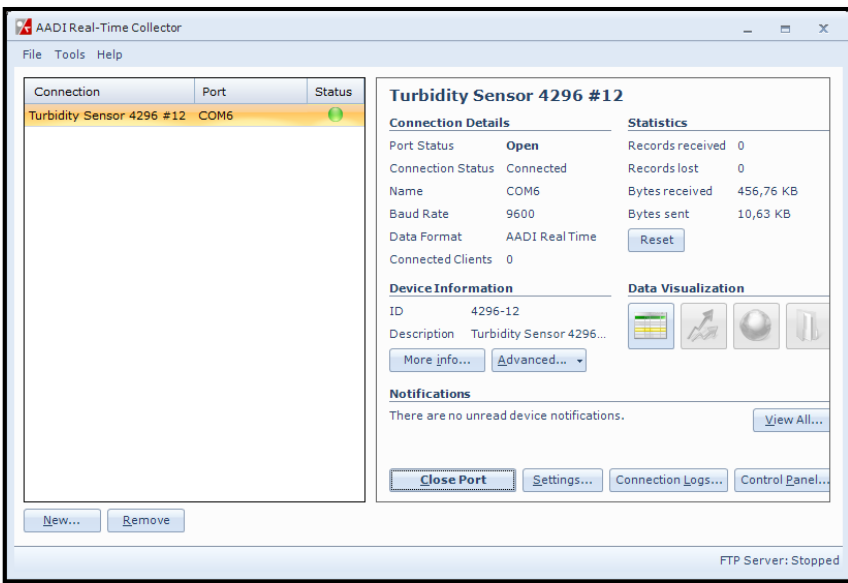
If you have multiple connections in your list, then highlight the connection you want and then press **Open Port**.

It is possible to have multiple connections using the same port but only one of them can be open. This means that if you have another sensor connected to COM6 you need to close this port before you can open the new connection. Multiple connections can be open at the same time if they are connected to different ports.



When the connection is established, a small window will show up with a green check mark confirming this.

Figure 3-4: Connection established



The status changes to green when the port is open.

Then click on the **Control Panel** button on the lower right corner to continue.

Figure 3-5: Green Status

If the wheel continues turning and you do not get the green status, please press **Close Port** and then **Open Port** again. If you still face a connection problem, then check the port setting with **Baud Rate** and **Port Name**. If you still cannot connect, check the cable connection and make sure that you have power to the sensor. If the sensor is running on a fast interval this connection can be a bit slower.

### 3.2 Control Panel

In the **Control Panel** window, you will find two tabs, **Recorder Panel** and **Device Configuration**. Under **Recorder Panel** you can start and stop recordings. If the recorder is running first click on the **Stop Recorder** as you are not allowed to configure the sensor when recording. The **Recorder Panel** is dependent on the Sensor Mode. In **AADI Real-Time** mode you may start and stop the recorder. For **AiCaP** and **Smart Sensor Terminal** you can only refresh the status but not start the recording.

### 3.2.1 Recorder Panel

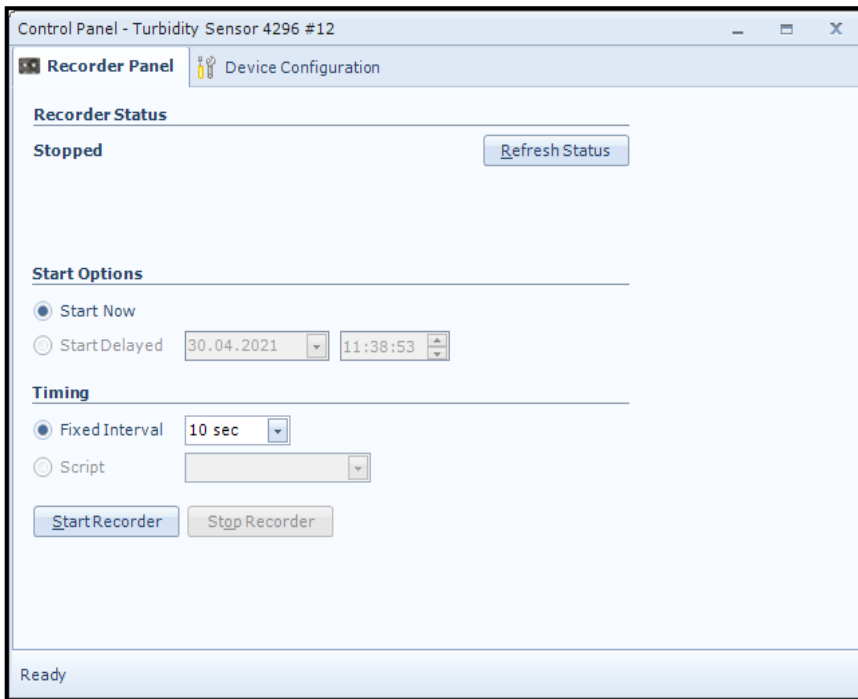


Figure 3-6: Recorder Panel

Under **Start Options** you can start the sensor immediately by **Start Now**. The **Start Delayed** option is possible for stand-alone sensors.

In the **Timing** session you may select the recording interval using **Fixed Interval**. The available interval will be dependent on the sensor configuration.

If you change the configuration it might cause a change in the **Fixed Interval**, so we recommend always checking the interval after configuration is finished.

The **Script** is not used for this sensor.

### 3.2.2 Device Configuration

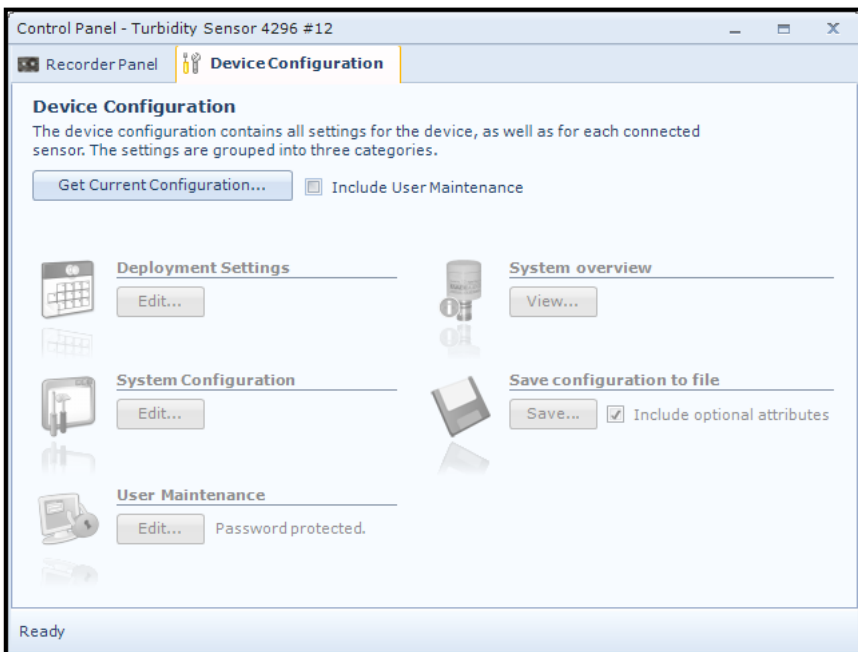


Figure 3-7: Device Configuration

Click on the **Device Configuration** tab to continue and access the sensor property menus.

Under the **Device Configuration** tab click on the **Get Current Configuration...** button to read the current configuration from the sensor.

To include the **User Maintenance** settings tick off the **Include User Maintenance** box before clicking the **Get Current Configuration...**

The settings in **User Maintenance** are protected with a higher access level. To access this menu you will need to enter a **password**.

This **password is 1000** for all sensors.

The device configuration is separated into **Deployment settings, System Configuration, User Maintenance, System overview** and **Save configuration to file**.

You can save current settings to a backup file by pressing **Save...** under the heading **Save configuration to file**. Edit the name for your file and press **Save** to save the configuration to file in .xml format. Use **XML Config Documentation Generator** to convert from .xml to Word. This generator is available from our website. Converting from .xml shown below

```

<PropertyCategory ID="0" Descr="Mandatory">
  <Property ID="0" Descr="Product Name" Type="VT_BSTR" Access="R1W4">Turbidity Sensor</Property>
  <Property ID="1" Descr="Product Number" Type="VT_BSTR" Access="R1W4">4296</Property>
  <Property ID="2" Descr="Serial Number" Type="VT_I2" Access="R1W4">12</Property>
  <Property ID="6" Descr="SW ID" Type="VT_BSTR" Access="R1">1940007</Property>
  <Property ID="3" Descr="SW Version" Type="VT_ARRAY|VT_I2" Access="R1">5;4;2</Property>
</PropertyCategory>
<PropertyCategory ID="5" Descr="Sample Settings">
  <Property ID="3" Descr="Range" Type="VT_I2" Access="R1W2">2</Property></PropertyCategory>

```

Figure 3-8: Configuration file saves as .xml

to a more readable .doc format as shown below.

Mandatory	
Product Name	Turbidity Sensor
Product Number	4296
Serial Number	12
SW ID	1940007
SW Version	5;4;2
Sample Settings	
Range	2

Figure 3-9: Configuration file converted to .doc

**System overview** shows a short list of sensor properties like product name, serial number and Software version.

User accessible sensor properties are found in **Deployment settings, System Configuration** and **User Maintenance**. Refer **chapter 1.7.1** trough **1.7.4** for an overview of the properties.

**Note! The screen shots might show minor discrepancies compared to screen shots taken from your sensor due to sensor updates.**

**Note! We recommend that you verify the system settings prior to starting a recording session.**

### 3.3 Changing Values

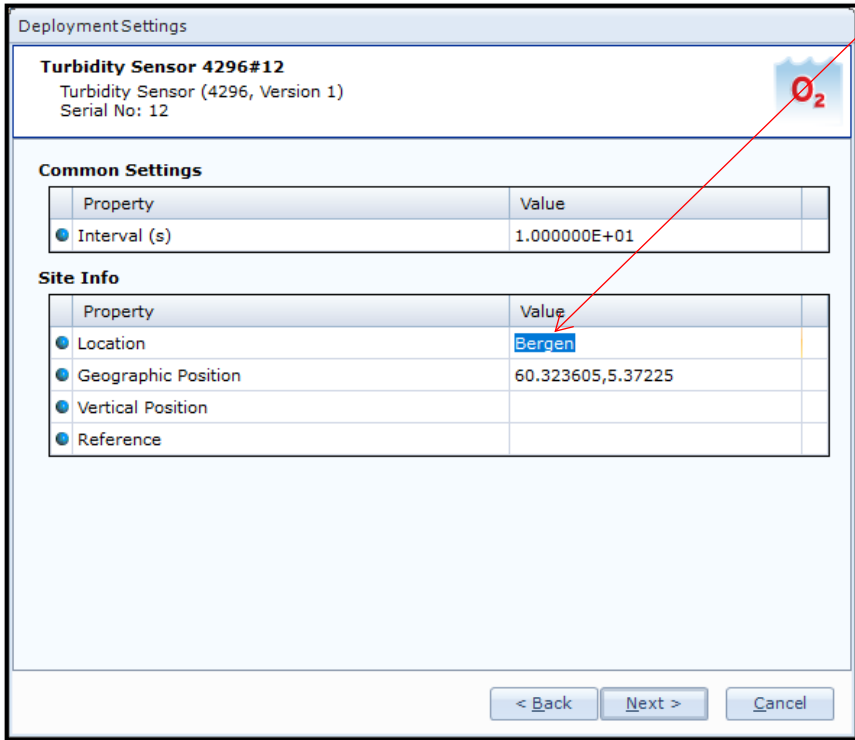


Figure 3-10: Change value

To change the content of a property first tick in the value box of the actual property and then enter the text or number before pressing **Next**. See example in **Figure 3-10**, where the text for **Location** has been changed.

The value is not changed before you have finished the full process. If you press **Cancel** or turn of the power then the changes will not be stored.

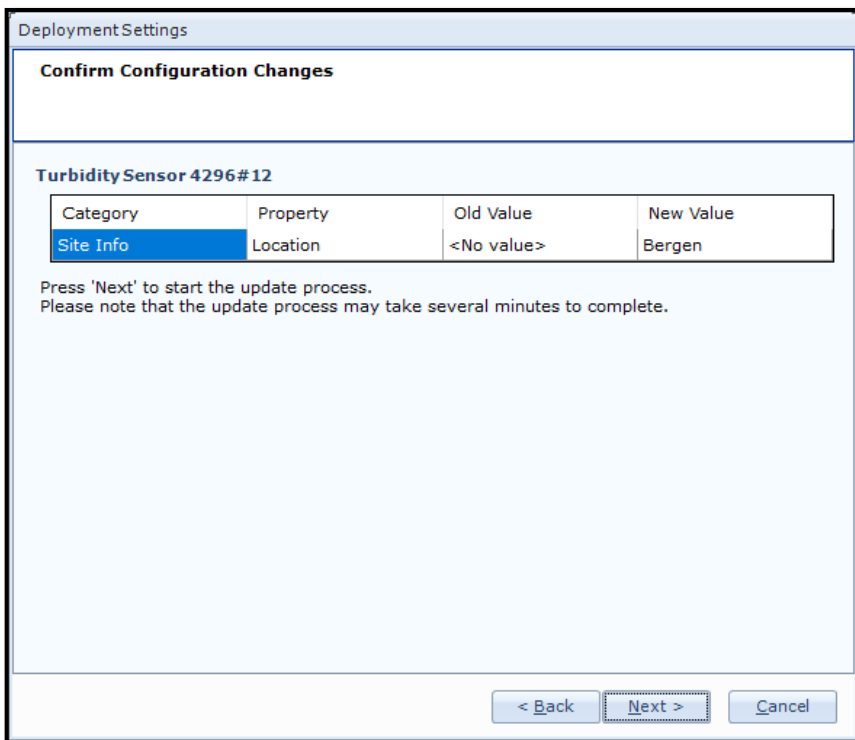


Figure 3-11: Confirm Configuration Changes

In the next picture a list of all properties that are changed will show up. If the list of configuration changes is correct press **Next** to start the update process.

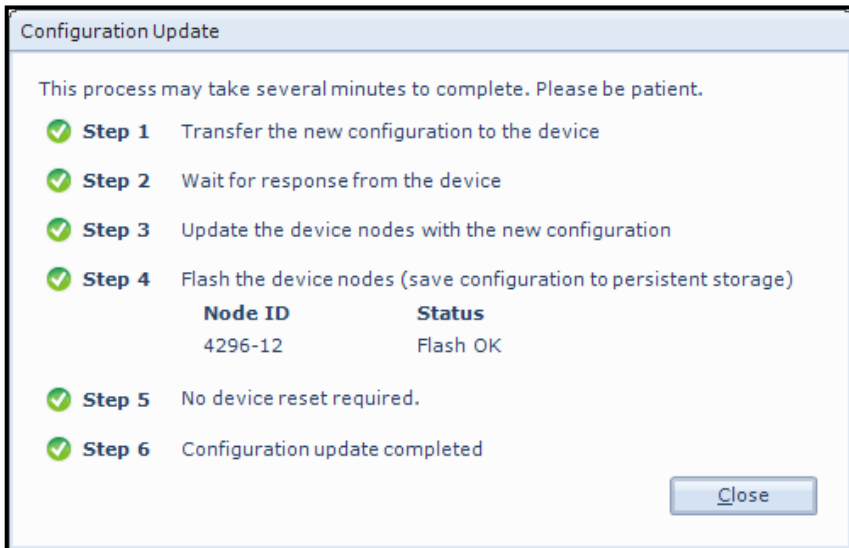


Figure 3-12 Configuration Update

An automatic process will start with 6 steps transferring and storing the new information/setting in the sensor Flash.

If necessary, a reset will be executed. Do not switch off before the entire process is completed.

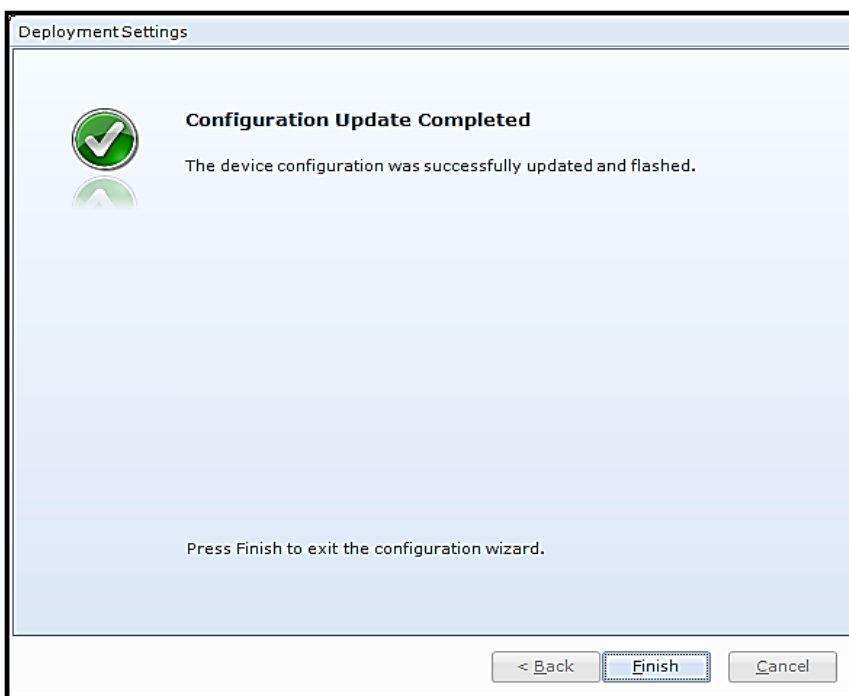
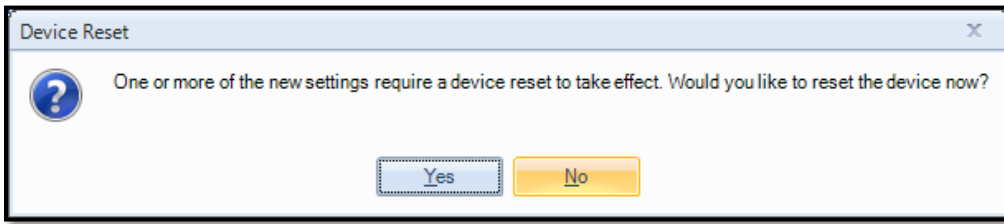


Figure 3-13 Configuration Update Completed

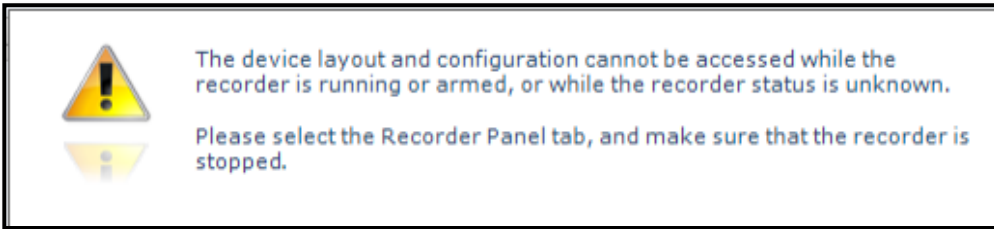
When the updating process is finished a confirmation will show up. Press **Finish** to continue.

Before you can continue you might need to go to the **Recorder Panel** and press **Refresh Status**.



Some changes may require a device reset to take effect. Press **Yes** to continue.

Figure 3-14: Device Reset

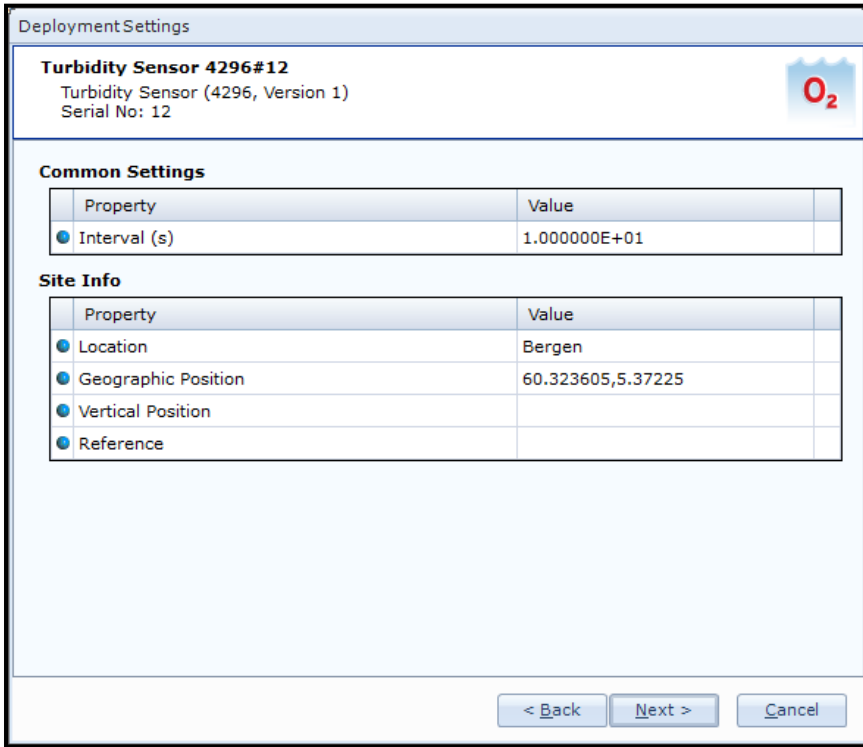


Some changes may require that you stop the recorder or refresh the status ***in Record panel.***

Figure 3-15: Warning

### 3.4 Deployment Settings

In the Device Configuration window select Deployment Setting by ticking the Edit button following the header, refer *Figure 3-7*.



This menu holds two different sections, **Common Settings** and **Site Info**.

Under **Common Settings** you will find only one property, **Interval (s)**. This setting is used to control the sensors recording interval.

The settings under **Site Info** are only used as info and will not influence on the measurement or sensor behavior.

See **chapter 3.4.1** to **3.4.2** for an explanation of each property.

All parameters are also listed in **chapter 1.7.2**

Figure 3-16: Deployment Settings

#### 3.4.1 Common Settings



Figure 3-17: Common Settings

Under **Common Settings** you will find only one property, **Interval (s)**. This setting is used to control the sensors recording interval, the number of seconds between each output. This setting may also be set from **Recorder Panel**. The last entered value will be the valid one if properly stored to flash.



### 3.4.2 Site Info

Site Info	
Property	Value
Location	Bergen
Geographic Position	60.323605,5.37225
Vertical Position	
Reference	

Figure 3-18: Site Info

**Site Info** is optional information to be entered to store information about the deployment. These settings are not used in internal calculations only stored as a part of the sensor Meta data.

**Geographical Position** is however used to give the map coordinates to display software or post processing software unless a GPS input is connected. The Properties under **Site Info** are:

- **Location**
- **Geographical Position**
- **Vertical Position**
- **Reference**

**Location** is typically the Site name or any name that can be used later to identify the location.

**Geographical Position** is normally the GPS Coordinates for the deployment. This might also be used to reproduce position in an electronic map.

**Vertical Position** is used to set the deployment depth or position in a chain of sensors.

**Reference** is a field where you might add information to be stored in the sensor metadata.

## 3.5 System Configuration

**System Configuration**

**Turbidity Sensor 4296#12**  
Turbidity Sensor (4296, Version 1)  
Serial No: 12

**Common Settings**

Property	Value
Mode	AADI Real-Time
Enable Sleep	<input checked="" type="checkbox"/>

**Terminal Protocol**

Property	Value
Enable Polled Mode	<input type="checkbox"/>
Enable Text	<input checked="" type="checkbox"/>
Enable Decimalformat	<input checked="" type="checkbox"/>

**Output Settings**

Property	Value
Enable Rawdata	<input type="checkbox"/>
Enable Temperature	<input checked="" type="checkbox"/>
Enable TSS	<input checked="" type="checkbox"/>

< Back   Next >   Cancel

**System Configurations** holds three different sections that are controlling the output from the sensor. The sections are:

- **Common Settings**
- **Terminal Protocol**
- **Output Settings**

Figure 3-19: System Configuration

See [chapter 3.5.1 to 3.5.6](#) for an explanation of each parameter. Please note that some of the parameters are linked to specific modes and have no influence if the sensor is set to a different mode.

All parameters are also listed in [chapter 1.7.3](#)

### 3.5.1 Common Settings

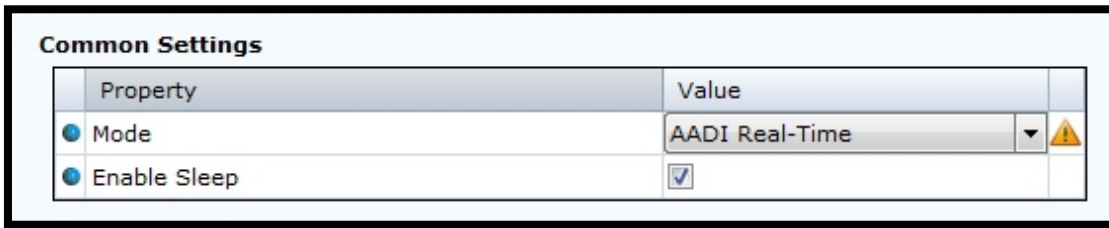


Figure 3-20: Common Settings in System Configuration

The **Common Settings** are available as shown in **Figure 3-20**.

**Mode:** The communication protocol must be defined under “**Mode**”. There are four different choices:

- **AiCaP** mode: If the sensor is going to be used on a SeaGuard, SeaGuardII or SmartGuard Datalogger, the mode must be changed to **AiCaP** mode first and saved before connecting it to the Datalogger.
- **AADI Real-Time** is the correct mode (protocol) when used together with AADI Real-Time Collector. This is an xml-based protocol which includes more metadata in the data messages. If the sensor is connected via RS-232 to the PC it is possible to configure the sensor either it is set to AiCaP, AADI Real-Time or Smart Sensor Terminal, but it is not possible to run and log data with AADI Real-Time Collector unless the sensor is set to AADI Real-Time.
- The **Smart Sensor Terminal** protocol is a simplified ASCII protocol which is easier to use together with a PC terminal program. This protocol is described more detailed in **CHAPTER 5**.
- **Smart Sensor Terminal FW2** is compatible with the older versions of Smart Sensor Terminal. This is normally only used if you need an output string like an older version of the sensor.

**Notice that the sensor always must be reset when the protocol/mode has been changed.**

**Enable Sleep:** This setting gives lower power consumption in AADI Real-Time and Smart Sensor Terminal mode when the sensor is able to go to sleep between measurements.

### 3.5.2 Terminal Protocol

Terminal Protocol	
Property	Value
<input type="checkbox"/> Enable Polled Mode	<input type="checkbox"/>
<input checked="" type="checkbox"/> Enable Text	<input checked="" type="checkbox"/>
<input type="checkbox"/> Enable Decimalformat	<input type="checkbox"/>

Figure 3-21: Terminal Protocol settings in System Configuration

The properties in this menu are highly dependent on the mode setting. If sensor is set to **AiCaP** these properties have no influence on the sensor. In **AADI Real-Time** mode only **Enable Polled mode** will be active. In **Smart Sensor Terminal** and **Smart Sensor Terminal FW2** mode all three properties are used.

If the **Enable Polled Mode** is enabled, then the sensor outputs data when the user/system polls for data with a **Do Sample** command.

**Enable Text** and **Enable Decimalformat** control the output string in Smart Sensor Terminal.

With **Enable Text** enabled the sensor will output a string with parameter name together with each reading, refer **chapter 5.8.4** for an example where this command is toggled.

**Enable Decimalformat** toggle between decimal format like 0.10 and Engineering format like 1.000E-01.

### 3.5.3 Output Settings

Output Settings	
Property	Value
Enable Rawdata	<input type="checkbox"/>
Enable Temperature	<input checked="" type="checkbox"/>
Enable TSS	<input checked="" type="checkbox"/>

Figure 3-22: Output settings in System Configuration

These settings are used to control the sensor serial output. The parameters will be included in the serial output string if setting is enabled. These settings do not influence the internal use of these parameters.

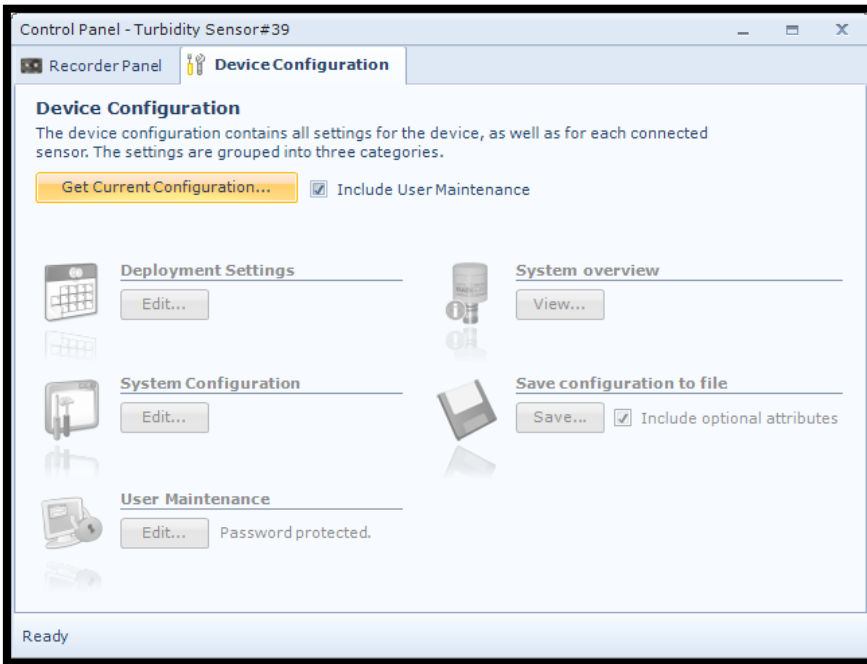
**Enable Rawdata.** This setting toggles on and off a set of raw data readings from the serial output string. These rawdata readings are used internally in the calculation independently of this setting. The parameters are:

- C1Amp(mV): Amplitude measurement with
- C2Amp (mV): Amplitude measurement with
- RawTemp(mV): Voltage from Thermistor Bridge.

**Enable Temperature.** This setting is used to enable or disable the **Temperature** output. The temperature reading is used to compensate for internal temperature drift when turbidity level is calculated independently of this setting

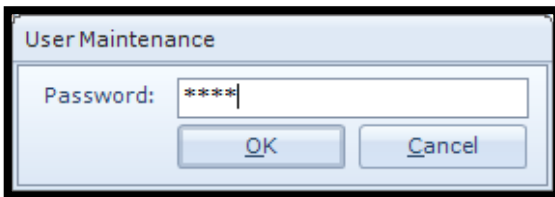
**Enable TSS,** enables the calculation of **TSS** based on the coefficients stored in **TSSCoef**. See **chapter 8.1** for more info about this measurement.

### 3.6 User Maintenance



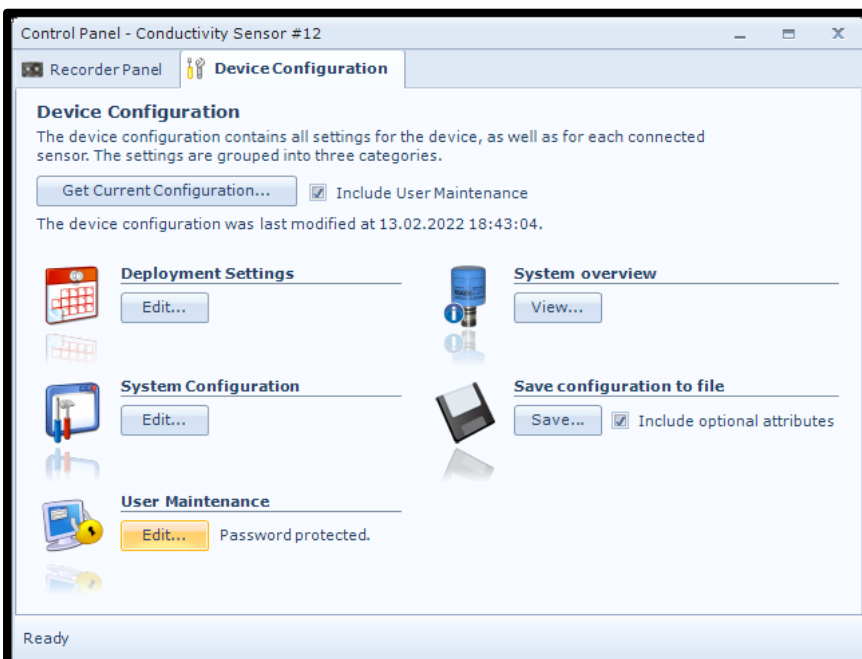
To access the **User Maintenance** menu, you first need to tap **Include User Maintenance**.

Figure 3-23: Control Panel - Device Configuration



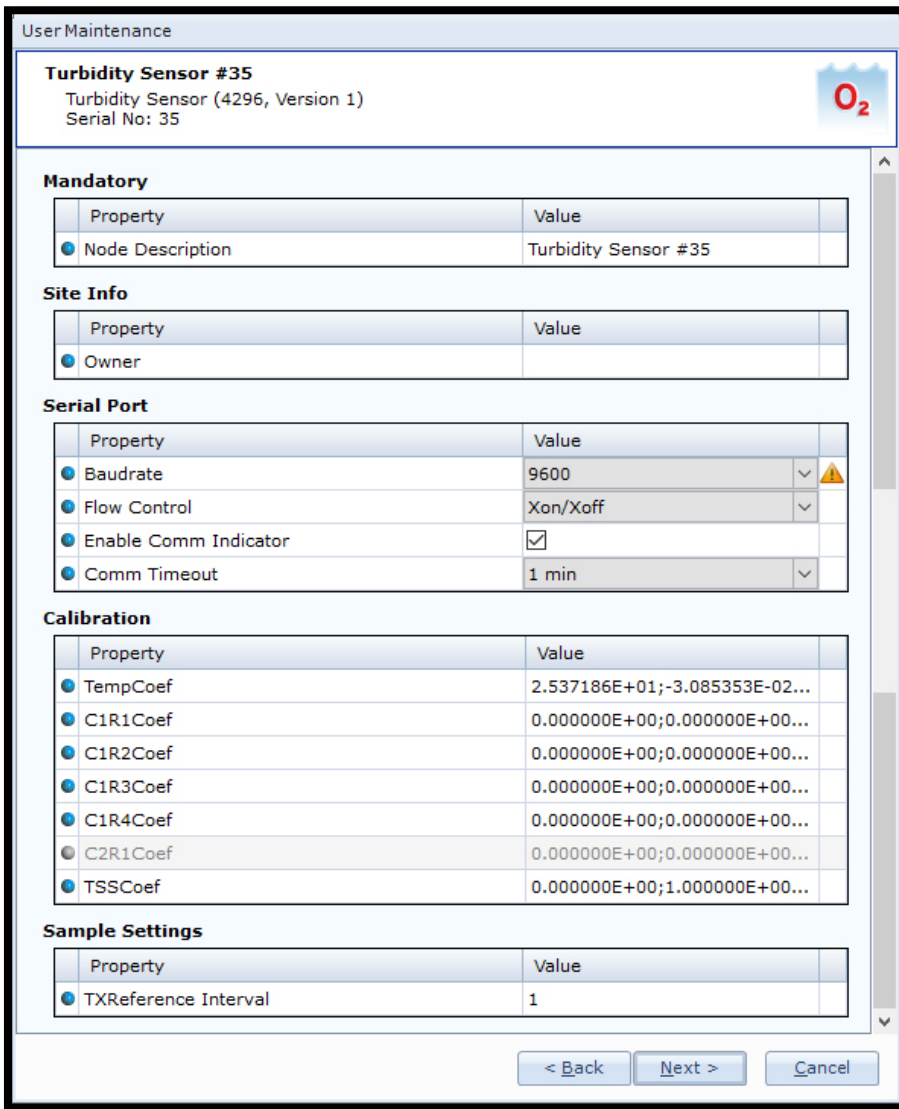
You then need to enter the **password that is 1000** for all units. And press **OK**.

Figure 3-24: Password



And then select **Edit** under the **User Maintenance**. If you don't tap the **Include User Maintenance** box and not enter the password the **User Maintenance** will stay grey and it will not be clickable.

Figure 3-25: Device Configuration - User Maintenance



Under **User Maintenance**, you find properties that are password protected and are set or altered by a trained user. It is not recommended to change properties unless instructed. This menu consists of five sessions:

- **Mandatory**
- **Site Info**
- **Serial Port**
- **Calibration**
- **Sample Settings**

For a full description of each property please refer to **chapter 3.6.1 to 3.6.5**.

Figure 3-26: User Maintenance

### 3.6.1 Mandatory

Mandatory	
Property	Value
Node Description	Turbidity Sensor #35

Figure 3-27: Mandatory in User Maintenance

In the **Mandatory** section you will find only one property, **Node Description**. All sensors are given a **Node Description** text like Turbidity Sensor #xxx (xxx is the serial number of the sensor) by default. The user can modify this **Node Description** text if required. Be aware that the **Node Description** changes to **\*Corrupt Configuration** if it has lost the configuration in flash. Contact the factory if this happens. The configuration is saved in two sectors in flash memory. A flash sector can be corrupted if the power is lost during the saving of new configuration. The double flash sector saving ensures that it does not lose the configuration. If one of the sectors is corrupted, the other sector is used and saved to the corrupt sector.

### 3.6.2 Site Info

Site Info	
Property	Value
Owner	Aanderaa

Figure 3-28; Site Info in User Maintenance

In the **Site Info** section you will find only one property. **Owner** is optional information to be entered to store information about the owner. This setting is not used in calculation. By default, this setting is empty.



### 3.6.3 Serial Port


Serial Port	
Property	Value
Baudrate	9600 
Flow Control	Xon/Xoff
Enable Comm Indicator	<input checked="" type="checkbox"/>
Comm Timeout	1 min

Figure 3-29: Serial Port settings in User Maintenance

The **Serial Port** group contains setting that deals with the RS-232 setup. When using RS-232 make sure that the sensor setting is the same as terminal software set-up. The default settings from factory for **Baudrate** are **9600** and **Flow Control** is set to **Xon/Xoff**. **Enable Comm Indicator** is enabling communication sleep ('%') and communication ready (!) indicators, when set to **Smart Sensor Terminal** mode, '!' indicates that the sensor is ready to communicate after sleep and '%' indicates that the sensor is going to sleep due to inactivity longer than the value/time set in **Comm Timeout**. The default settings are **Enable Comm Indicator** enabled and **Comm Timeout** set to **1 min**.

### 3.6.4 Calibration

Calibration	
Property	Value
<input checked="" type="radio"/> TempCoef	2.537186E+01;-3.085353E-02...
<input checked="" type="radio"/> C1R1Coef	0.000000E+00;0.000000E+00...
<input checked="" type="radio"/> C1R2Coef	0.000000E+00;0.000000E+00...
<input checked="" type="radio"/> C1R3Coef	0.000000E+00;0.000000E+00...
<input checked="" type="radio"/> C1R4Coef	0.000000E+00;0.000000E+00...
<input type="radio"/> C2R1Coef	0.000000E+00;0.000000E+00...
<input checked="" type="radio"/> TSSCoef	0.000000E+00;1.000000E+00...

Figure 3-30: Calibration coefficients in User Maintenance

The **Calibration** section contains 7 sets of calibration coefficients and settings. Except from the **TSSCoef** these coefficients are calculated during a calibration process at the factory and are not recommended to change for other than trained personal at Aanderaa certified calibration laboratories.

**TempCoef** is a set of 6 coefficients used as curve fitting coefficient for temperature measurements. Together with **RawTemp** it is used to calculate the absolute temperature.

**C1R1Coef, C1R2Coef, C1R3Coef and C1R4Coef** is calculated after calibration at factory for each of the four ranges. **C2R1Coef** is only for factory use and therefor write protected.

**TSSCoef** are used to convert the sensor reading to **TSS** based on local samples collected and filtered. See **chapter 8.1** for more info.

### 3.6.5 Sample Settings

Sample Settings	
Property	Value
<input checked="" type="radio"/> TXReference Interval	1

Figure 3-31: Sample Settings in User Maintenance

**TXReference Interval**; this is a sample interval divisor for use of **TXReference**. When the value is set to **1** (default) the **TXReference** measurement is performed during each sample. The value can be increased to reduce power drain or to set a faster sampling interval, less than **2** sec. When the value is set to e.g. **10**, the **TXReference** measurement is only performed for each 10<sup>th</sup> sample.

## CHAPTER 4 Configuration via SmartGuard or SeaGuardII Datalogger

### 4.1 Introduction

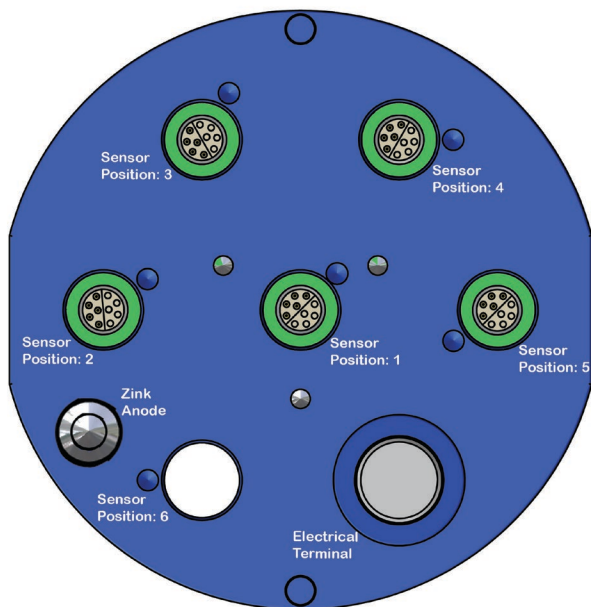
The Turbidity Sensor 4296 can easily be installed on the Aanderaa SeaGuard or SeaGuardII platform or connected using a cable. It can also be used with the SmartGuard Datalogger using a cable for surface buoy applications or placed on land.

For installation on SeaGuard with display see **CHAPTER 2**

To be able to control the Turbidity Sensor via SeaGuardII or SmartGuard the sensor needs to be in AiCaP mode.

### 4.2 Installation of the Turbidity Sensor 4296 on SeaGuardII

Power should be turned off before connecting the sensor. We recommend that you install the Turbidity Sensor in sensor position 3, 4 or 6, **refer Figure 4-1**. If mounted in position 6 use patch cable to connect the sensor to the HUB card.



**Important!**

*Refer SeaGuard Platform Operating Manual, TD303, for an illustrated sensor installation guide. TN309 holds an extract of sensor connection / disconnection given in the SeaGuard Operating Manual.*

**Note!**

*Always replace O-rings when removing, exchanging, or installing a new sensor or a sealing plug.*

Figure 4-1: SeaGurdII Top End plate

## 4.3 Configuration with AADI Real-Time collector

In this chapter we will show you how to configure the sensor when connected to a Aanderaa Platform. This configuration can also be done via a real-time output but to do this the Platform first need to be set up with a two-way real-time output.

### 4.3.1 Connected via SeaGuardII

- Connect the micro-USB configuration cable to the USB connector in front of the instrument and to the PC
- Install and start the AADI Real-Time Collector software on your PC. For more information about the AADI Real-Time Collector, refer TD 268 AADI Real-Time Collector Operating Manual
- Switch on the instrument by pressing the power button in the front of the instrument.
- Wait approximately 30 seconds before the instruments starts up and connection is established.

### 4.3.2 Connected via SmartGuard

- Connect the USB configuration cable to the USB connector on the left-hand side of the SmartGuard and to the PC
- Install and start the AADI Real-Time Collector software on your PC. For more information about the AADI Real-Time Collector, refer TD 268 AADI Real-Time Collector Operating Manual
- Switch on the logger by turning the power to the “ON”- position.
- Wait approximately 30 seconds before the logger starts up and connection is established.

## 4.4 Establish connection

### NOTE!

**When using a USB connection, you also need to install Windows Mobile Device Center (Windows Vista, and Microsoft Windows 7) if not already installed on your computer. If you don't have the installation file, please contact [aanderaa.support@xylem.com](mailto:aanderaa.support@xylem.com) for further assistance.**

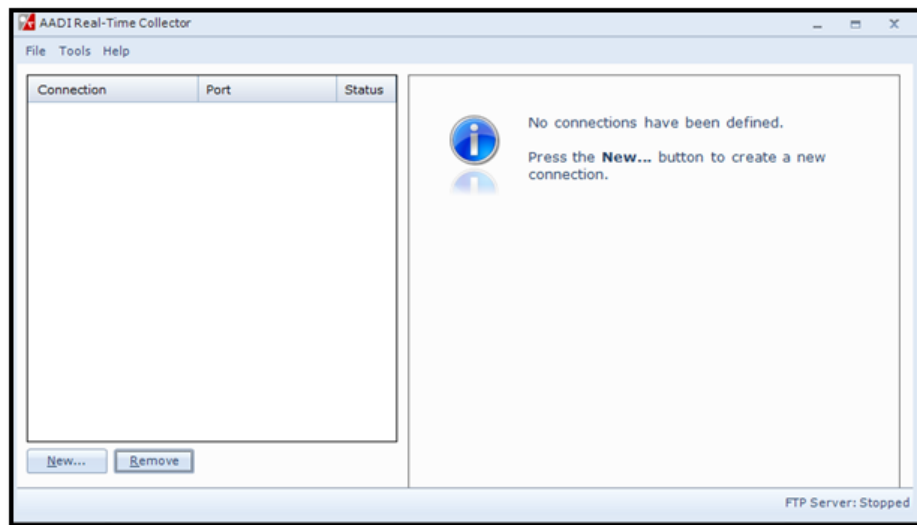
Windows Mobile Device Center acts as device management and data synchronization between a Windows Mobile-based device and a computer.

Once the USB connection has been established, Windows Mobile Device Center will start automatically:



You may close this window after connection is established.

Figure 4-2: Windows Mobile Device Center



At first connection with AADI Real-Time Collector the connection list will be empty. Click on the **New** button in the lower left corner to create a new connection.  
NOTE: This only need to be done once. AADI Real-Time Collector will keep the information for later use and next time you might select it from the connection list.

Figure 4-3: AADI Real-Time Collector start up menu

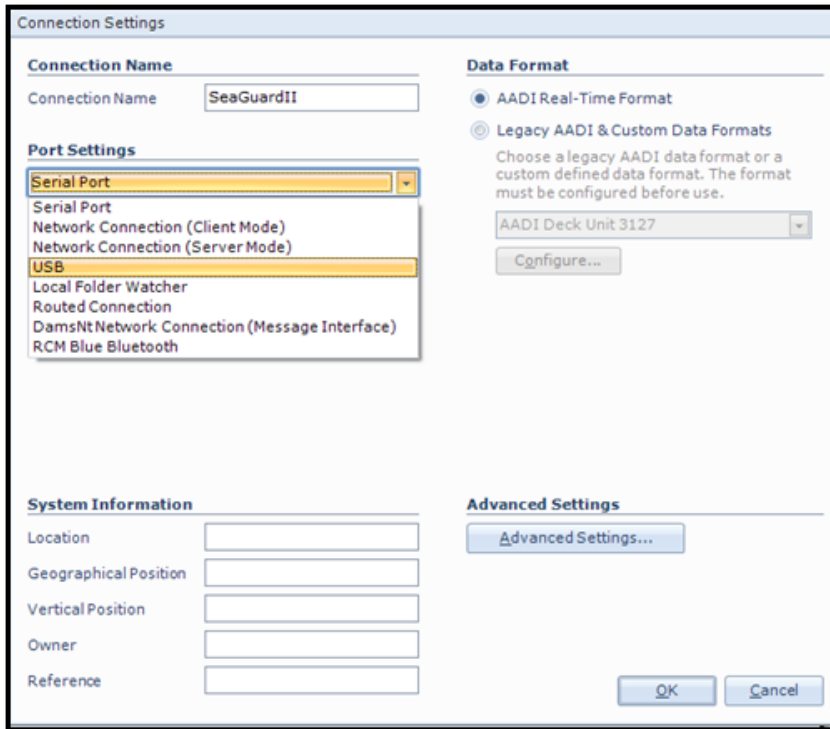


Figure 4-4: AADI Real time Collector connection settings

Select **USB** from the **Port Settings** drop down menu (Figure 4-4); and write a name in the **Connection Name** box (e.g. SeaGuardII). We recommend using product name and serial number if you want to connect multiple instruments to the same software.

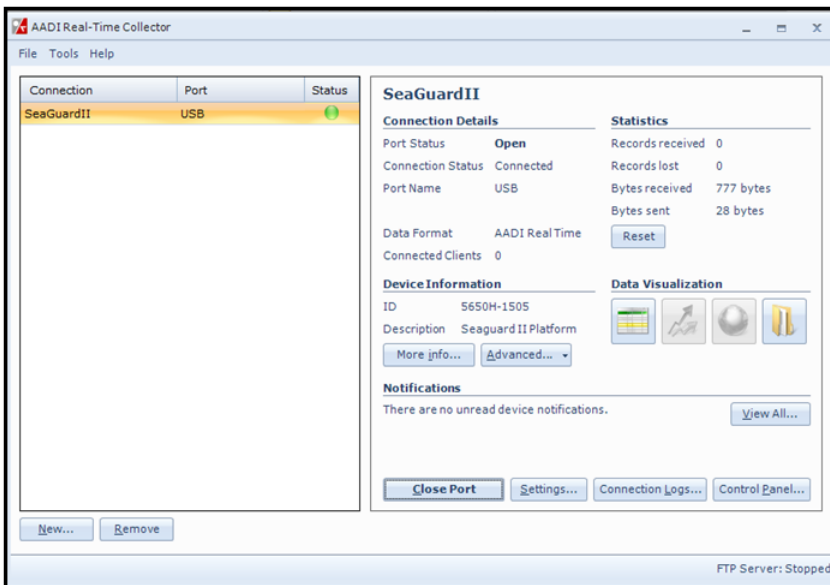


Figure 4-5: AADI Real-Time Collector main menu

The new connection is now shown in the AADI Real-Time Collector connection list. Click on the line with the new connection to highlight the line and then click on the **Open Port** button. The connection to the SeaGuardII/SmartGuard should be established within a few seconds and the status turn to green. After power up it will take approximately 30 seconds before the logger is ready.

Open **Control Panel** in the lower right corner (refer Figure 4-6).

### 4.4.1 Control Panel

In the **Control Panel** window you will find four tabs, **Recorder Panel**, **Device Configuration**, **Device Layout** and **System Status**. Under **Recorder Panel** you can start and stop recordings. If the recorder is running first click on the **Stop Recorder** as you are not allowed to configure the sensor when recording. For information about **Device Layout** and **System Status** see Manual for SeaGuardII Platform TD303 or SmartGuard TD293.

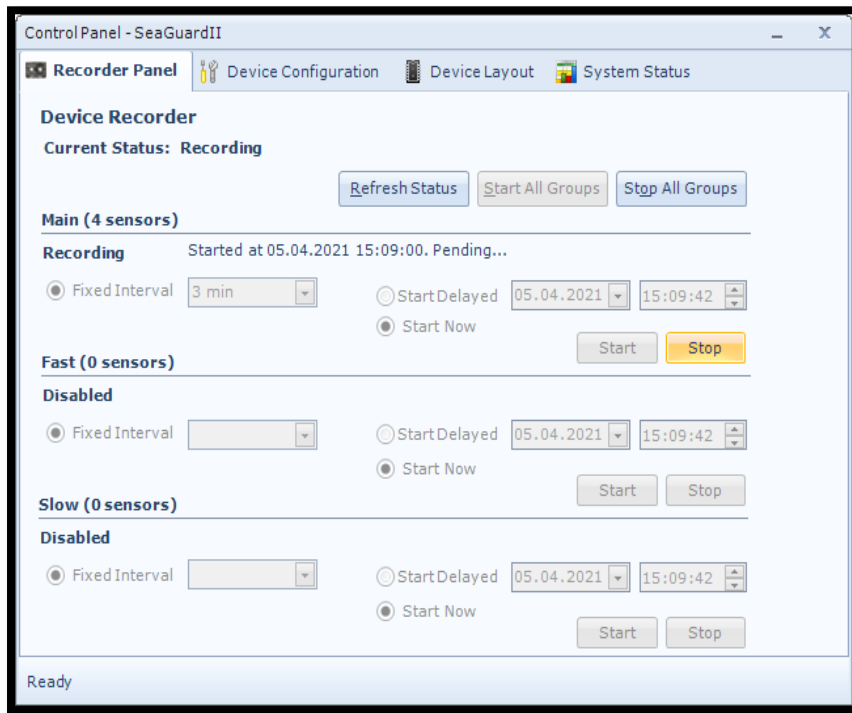


Figure 4-6: Recorder Panel

If the instrument is recording, under **Recorder Panel**, press **Stop All Groups**.

The **Control Panel** is controlling the SeaGuardII/SmartGuard recorder and not individual sensors. However the **Recorder Panel** consist of three recording groups where you might put individual sensors in each group to run them on different recording interval. See Operation Manual SeaGuardII / SmartGuard for more info.

Under each group you can start the group immediately by **Start Now**, or start later using the **Start Delayed** option

The layout of this menu will vary depending on the **Recorder** status and selections done in the **Deployment Settings > Multi Group Recorder** menu.

The **Fixed Interval** is the recording interval for each group. The configuration of sensors in each group will influence on the available recording interval. If you change the configuration of one sensor and this cause a longer processing time the **Fixed Interval** might be changed. We recommend that you always check the recording interval after any changes in configuration. **Fixed Interval** is not applicable in the **Recorder Panel** menu unless **Selectable in recorder panel** is selected in **Deployment Settings > Multi Group Recorder** menu.

**Start Delayed** is mainly used if you want to arm your instrument to start later. This can be useful if you configure the instrument in your office and don't want the instrument to record before the instrument is installed in water. **Start Delayed** can also be used to synchronize the start time for the three groups or between multiple instruments.

See Manual for SeaGuardII Platform TD303 or SmartGuard TD293 for more information about the **Multi Group Recorder** menu.

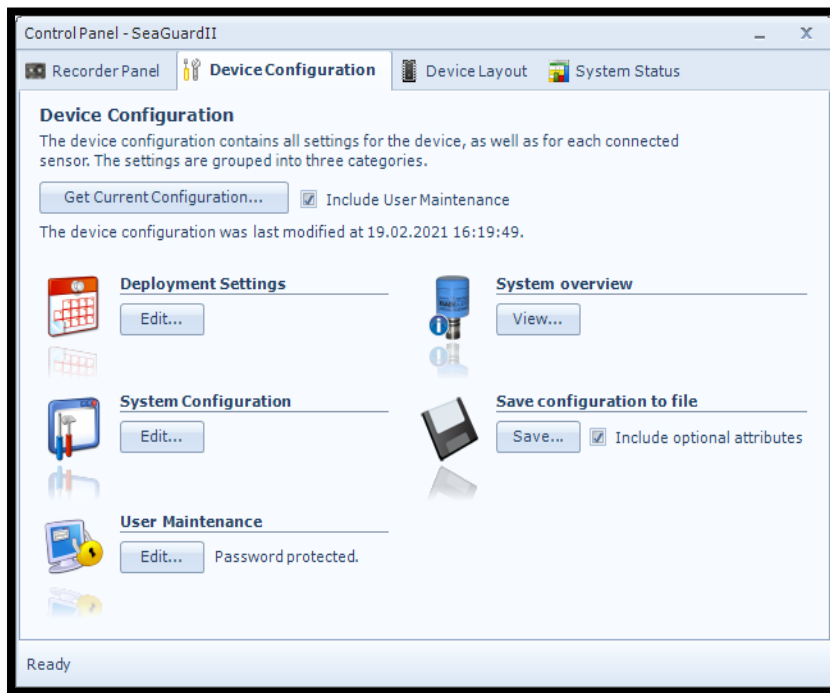


Figure 4-7: Device configuration

Each Sensor will do a calculation based on the configuration for each recording interval.

The device configuration is separated into **Deployment settings**, **System Configuration**, **User Maintenance**, **System overview** and **Save configuration to file**.

Settings related to the Turbidity sensor can be configured under **Deployment Settings**, **System Configuration** and **User Maintenance**.

**System overview** shows a short list of sensor properties like product name, serial number and Software version.

Under the heading **Save configuration to file** you can save current settings to a backup file by pressing **Save....** Edit the name and location for your file and press **Save** to store the new configuration to file in .xml format.

User accessible sensor properties are found in **Deployment settings**, **System Configuration** and **User Maintenance**. Refer **Table 1-6** to **Table 1-9** for an overview of the properties.

**Note! The screen shots might show minor discrepancies compared to screen shots taken from your sensor due to sensor updates.**

**Note! We recommend that you verify the system settings prior to starting a recording session.**



## 4.5 Changing Values

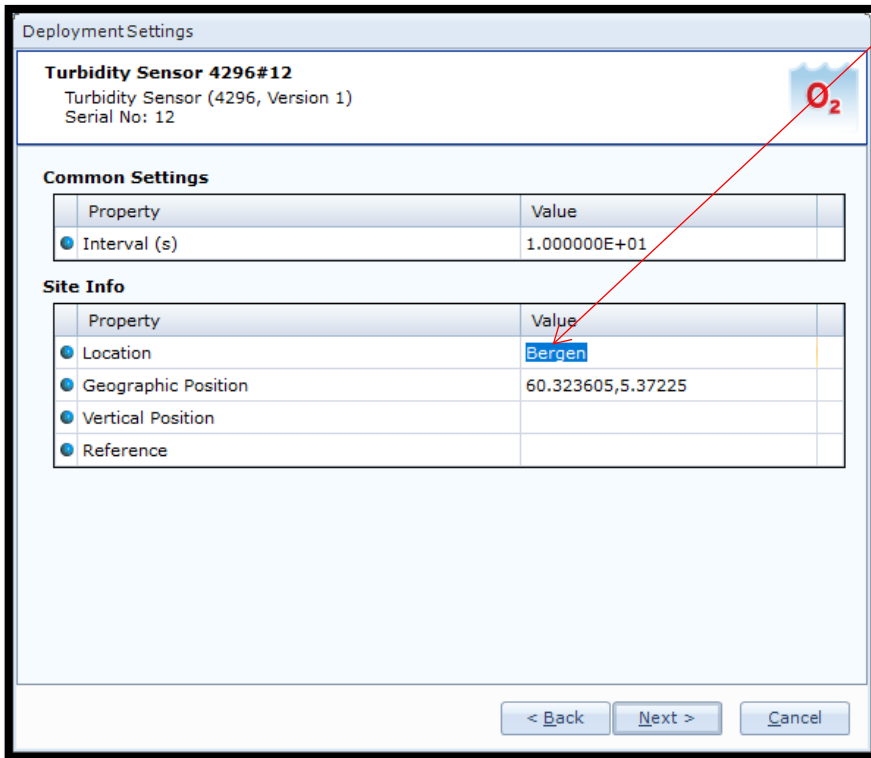


Figure 4-8: Change value

To change the content of a property first tick in the value box of the actual property and then enter the text or number before pressing **Next**. See *example where the text for **Location** has been changed.*

The value is not changed before you have finished the full process. If you press **Cancel** or turn of the power then the changes will not be stored.

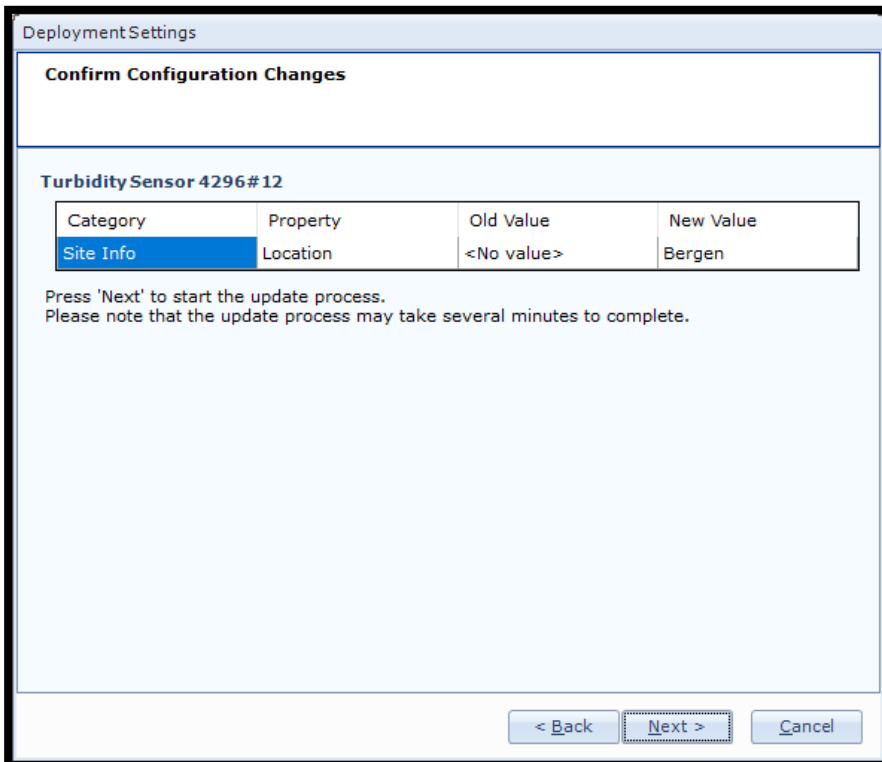
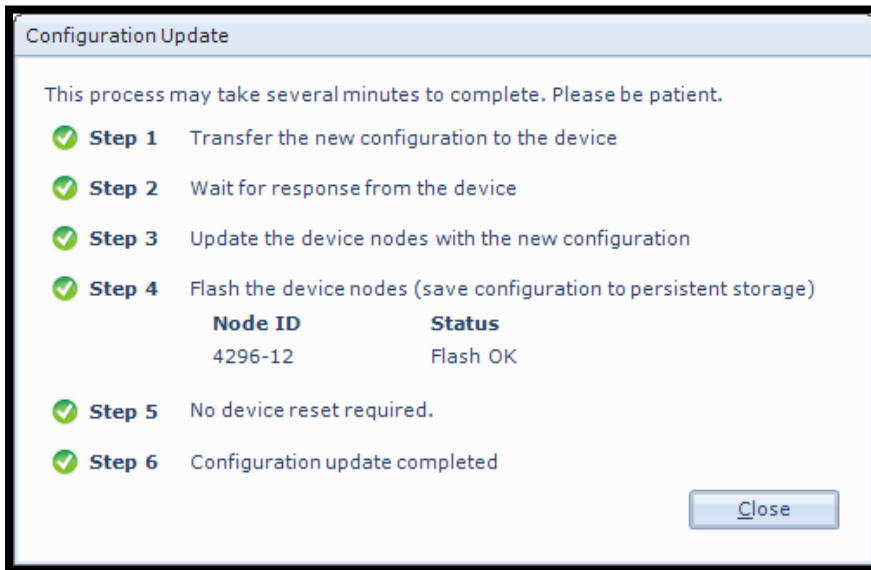


Figure 4-9: Confirm Configuration Changes

In the next picture a list of all properties that are changed will show up.

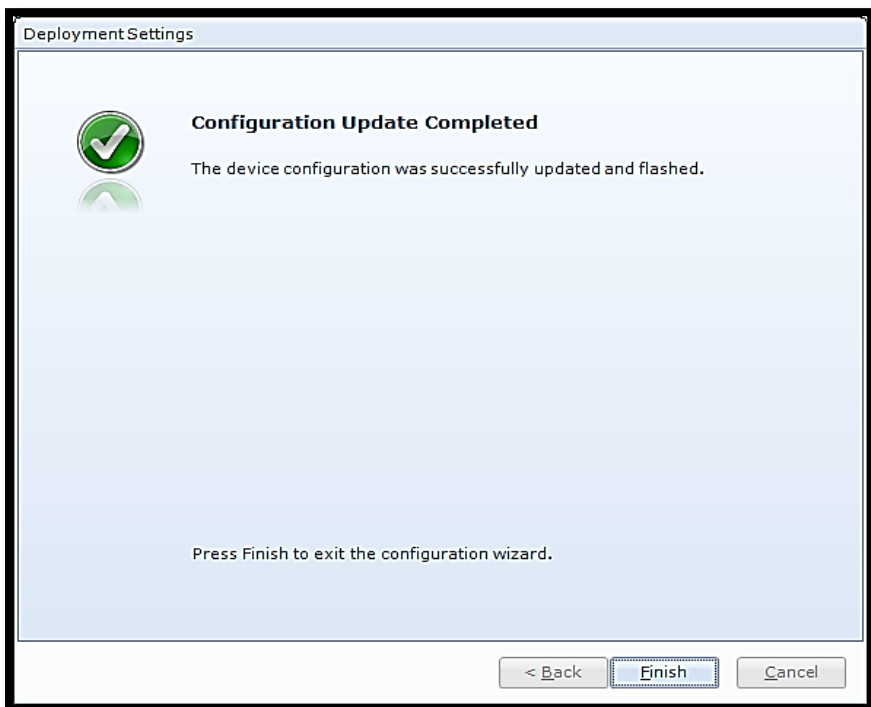
If the list of configuration changes is correct press **Next** to start the update process.



An automatic process will start with 6 steps transferring and storing the new information/setting in the sensor Flash.

If necessary, a reset will be executed. Do not switch off before the entire process is completed.

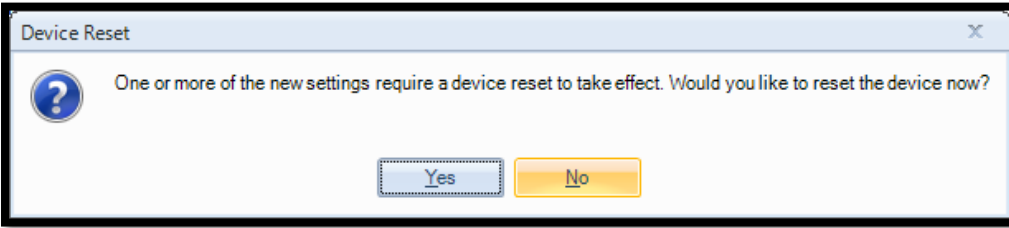
Figure 4-10 Configuration Update



When the updating process is finished a confirmation will show up. Press **Finish** to continue.

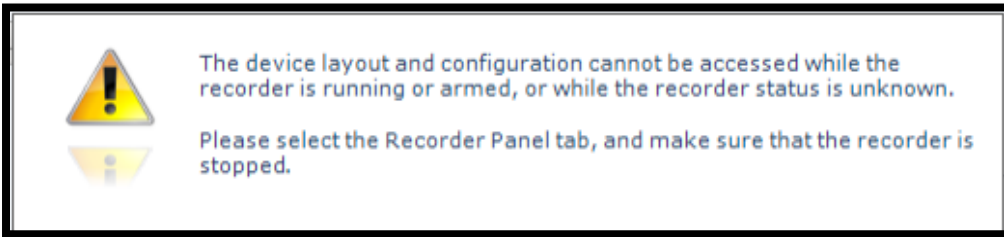
Before you can continue you might need to go to the Recorder Panel and press Refresh Status.

Figure 4-11 Configuration Update Completed



Some changes may require a device reset to take effect. Press Yes to continue.

Figure 4-12: Device Reset



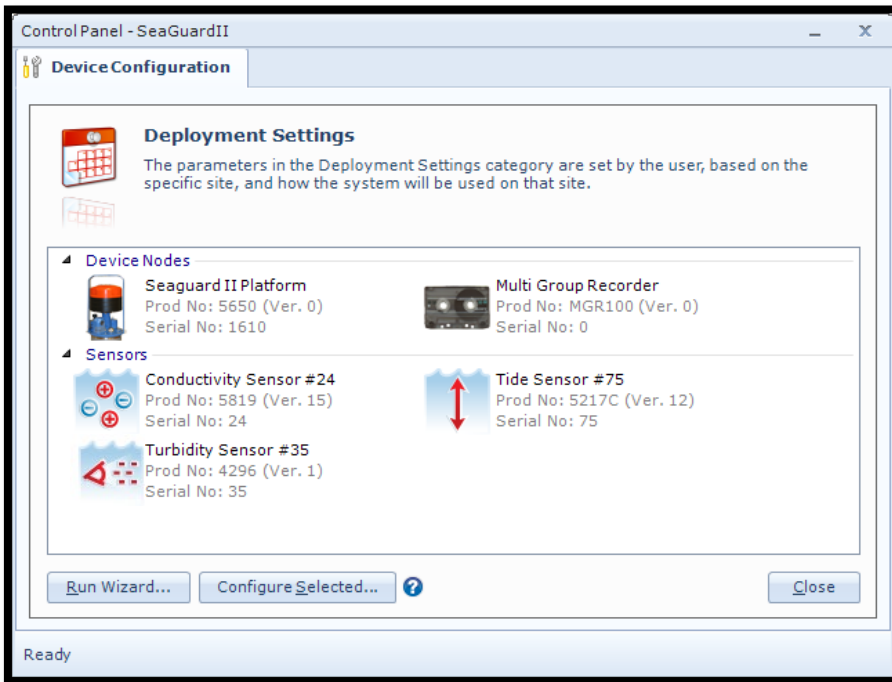
Some changes may require that you stop the recorder or refresh the status in Record panel.

Figure 4-13: Warning

**Note!** The screen shots might show minor discrepancies compared to screen shots taken from your sensor due to sensor updates.

**Note!** We recommend that you verify the system settings prior to starting a recording session.

## 4.6 Deployment settings

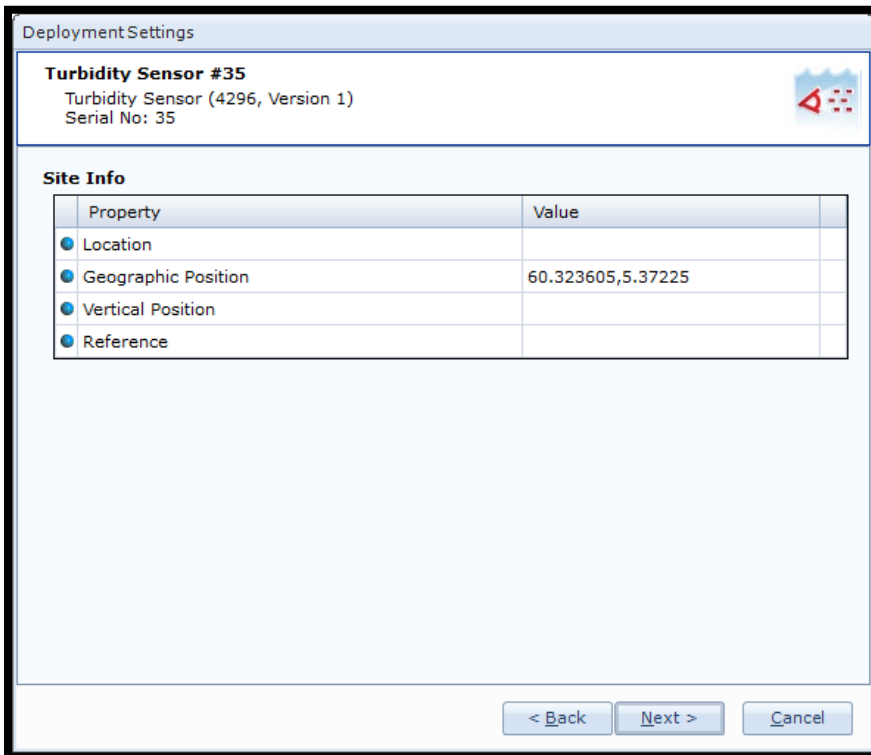


Under **Control Panel** select the **Device Configuration** tab and press The **Get Current Configuration...** box. Select **Edit...** underneath the **Deployment Settings** header.

Under **Sensors** all connected sensors will show up. All AiCaP sensors connected to the bus will automatically show up in the list after power-up.

Double-click on the **Turbidity Sensor** to select the sensor.

Figure 4-14: Deployment settings



The **Deployment Settings** contains only one group. The settings in this group are not used in any calculations.

These properties are optional and only used for information.

For more information on each property see **chapter 4.6.1**

Figure 4-15: Deployment Settings

### 4.6.1 Site Info

Site Info	
Property	Value
Location	Midtun
Geographic Position	60.323605,5.37225
Vertical Position	
Reference	

Figure 4-16: Site Info

**Site Info** is optional information to be entered to store information about the deployment. These settings are not used in internal calculations only stored as a part of the sensor metadata.

**Geographical Position** is however used to give the map coordinates to display software or post processing software unless a GPS input is connected. The Properties under **Site Info** are:

- **Location**
- **Geographical Position**  
1.
- **Vertical Position**
- **Reference**

**Location** is typically the Site name or any name that can be used later to identify the location.

**Geographical Position** is normally the GPS Coordinates for the deployment. This might also be used to reproduce position in an electronic map.

**Vertical Position** is used to set the deployment depth or position in a chain of sensors.

**Reference** is a field where you might add information to be stored in the sensor metadata.

## 4.7 System Configuration

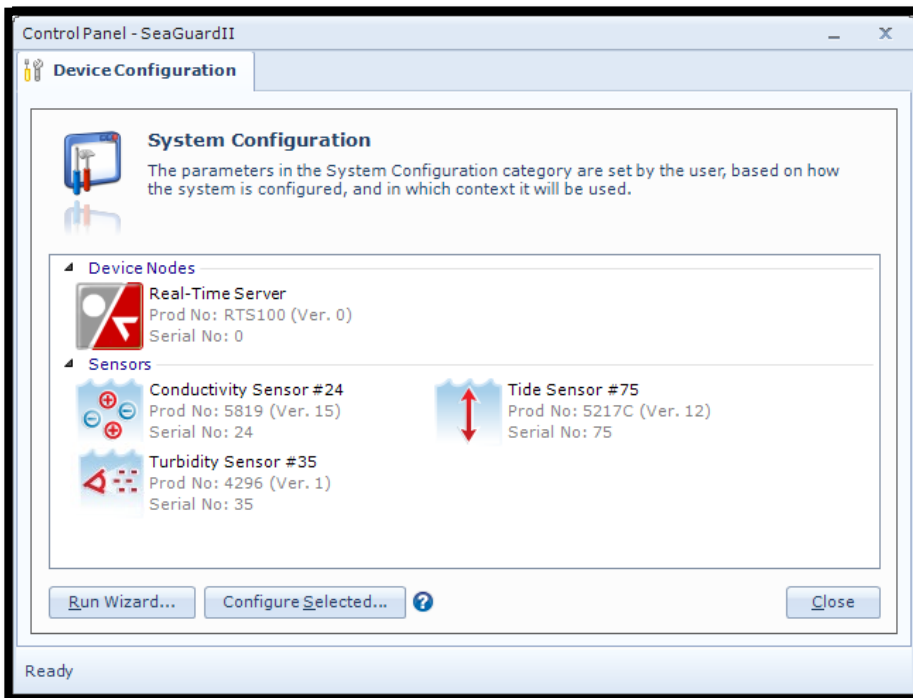


Figure 4-17: System configuration

Select **System Configuration** under **Device Configuration**. The different sensors connected to the same Datalogger will show up as selectable items.

Double-click on the **Turbidity Sensor** to start configuring.

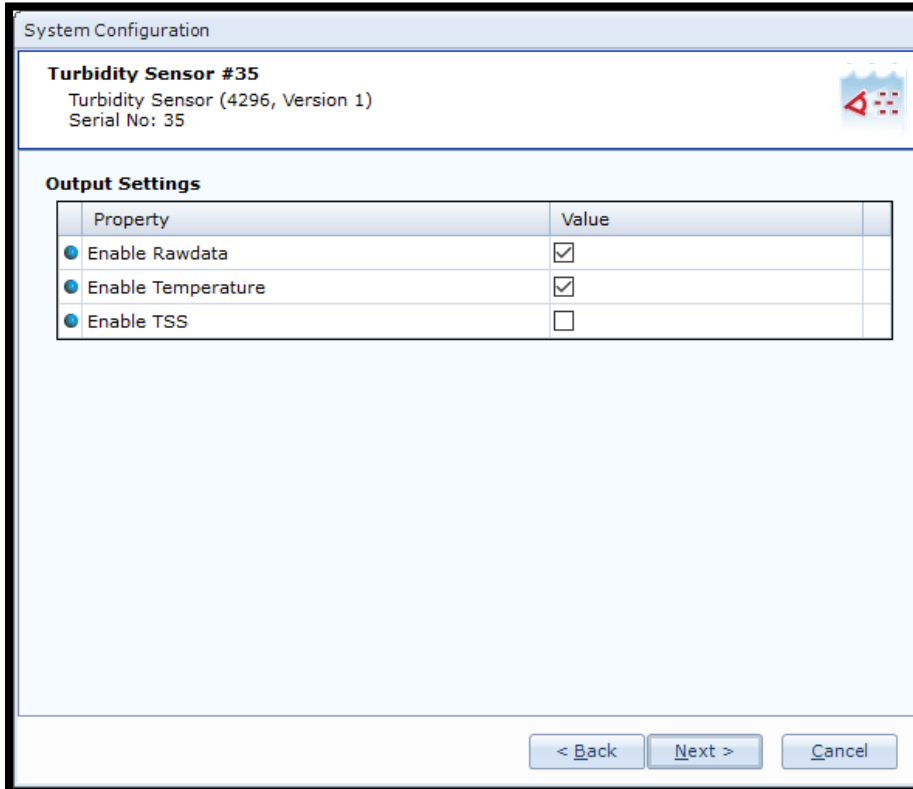


Figure 4-18: System Configuration

**System Configuration** has only one group, **Output Settings**. The settings in this group are mainly used to control the output of data.

For more information on each property, see **chapter 4.7.1**

### 4.7.1 Output Settings

Output Settings	
Property	Value
● Enable Rawdata	<input checked="" type="checkbox"/>
● Enable Temperature	<input checked="" type="checkbox"/>
● Enable TSS	<input type="checkbox"/>

Figure 4-19: Output Settings

These settings do not influence the internal use of these parameters.

**Enable Rawdata.** This setting toggles on and off a set of raw data readings from the serial output string. These rawdata readings are used internally in the calculation independently of this setting. The parameters are:

- C1Amp(mV):           Amplitude measurement with
- C2Amp (mV):        Amplitude measurement with
- RawTemp(mV):      Voltage from Thermistor Bridge.

**Enable Temperature.** This setting is used to enable or disable the **Temperature** output. The temperature reading is used to compensate for internal temperature drift when turbidity level is calculated independently of this setting

**Enable TSS,** enables the calculation of **TSS** based on the coefficients stored in **TSSCoef**. See **chapter 8.1** for more info about this measurement.

# 4.8 User Maintenance

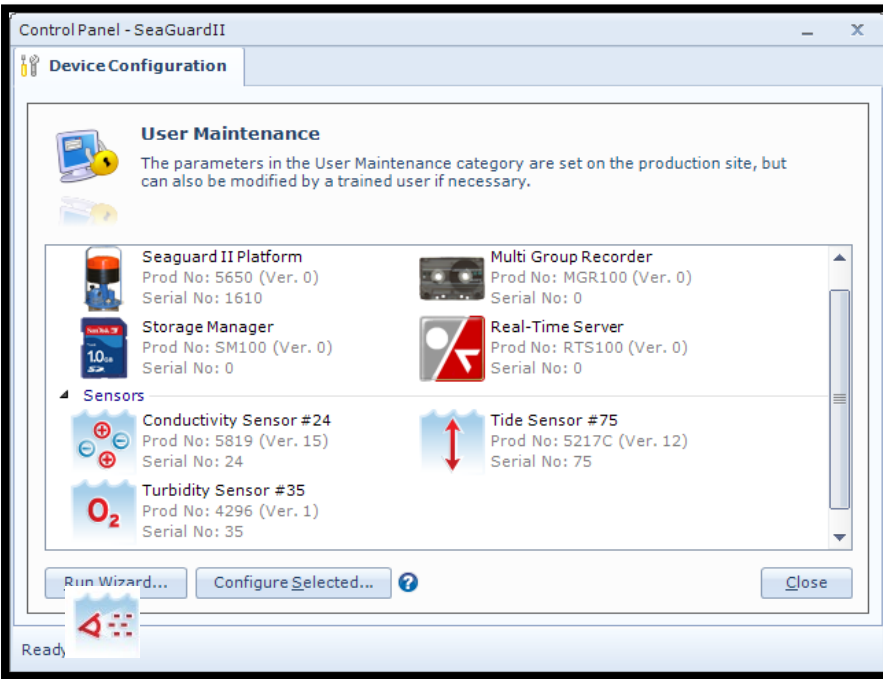


Figure 4-20: User Maintenance

Select **User Maintenance** under **Device Configuration**. The different sensors connected to the same Datalogger will show up as selectable items.

Double-click on the **Turbidity Sensor** to start configuring.

To access this menu, check the **“Include User Maintenance”** box in the **Device Configuration** before clicking on the **“Get Current Configuration...”** button. The password is: **1000**.

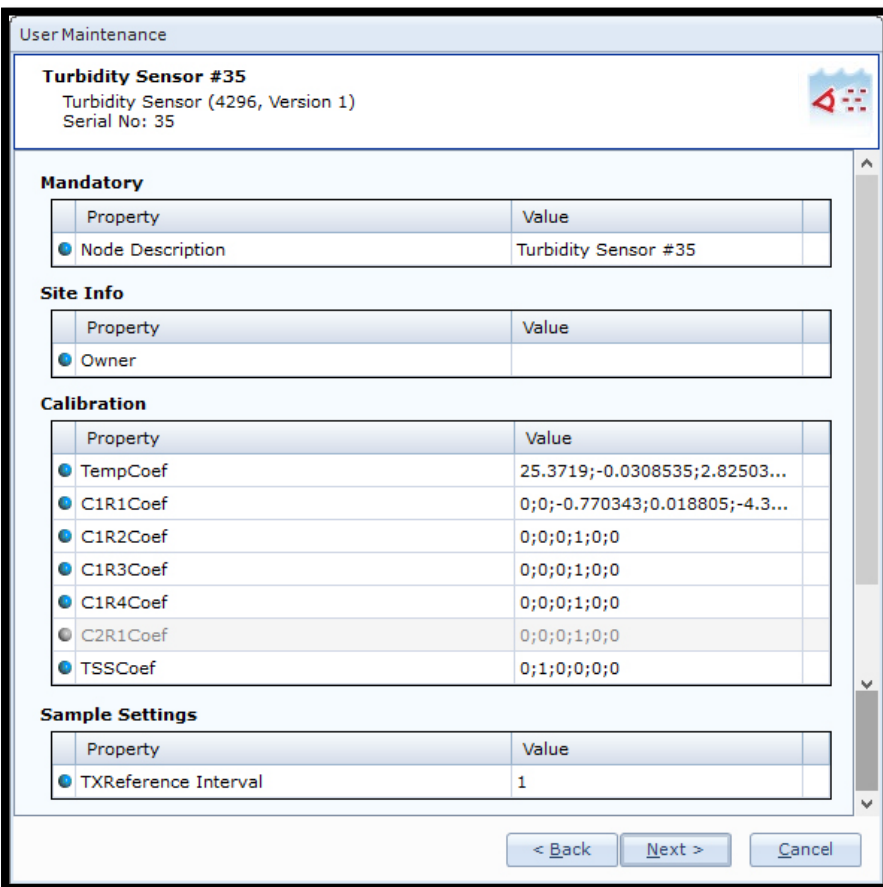


Figure 4-21: User Maintenance

Under **User Maintenance**, you find properties that are password protected and are set or altered by a trained user. It is not recommended to change properties unless instructed. This menu consists of four sessions:

- **Mandatory**
- **Site Info**
- **Calibration**
- **Sample Settings**

For a full description of each property please refer to **chapter 4.8.1** through **4.8.4**.



### 4.8.1 Mandatory

Mandatory	
Property	Value
<input checked="" type="radio"/> Node Description	Turbidity Sensor #35

Figure 4-22: Mandatory in User Maintenance

In the **Mandatory** section you will find only one property, **Node Description**. All sensors are given a **Node Description** text like Turbidity Sensor #xxx (xxx is the serial number of the sensor) by default. The user can modify this **Node Description** text if required. Be aware that the **Node Description** changes to **\*Corrupt Configuration** if it has lost the configuration in flash. Contact the factory if this happens. The configuration is saved in two sectors in flash memory. A flash sector can be corrupted if the power is lost during the saving of new configuration. The double flash sector saving ensures that it does not lose the configuration. If one of the sectors is corrupted, the other sector is used and saved to the corrupt sector.

### 4.8.2 Site Info

Site Info	
Property	Value
<input checked="" type="radio"/> Owner	Aanderaa

Figure 4-23; Site Info in User Maintenance

In the **Site Info** section, you will find only one property. **Owner** is optional information to be entered to store information about the owner. This setting is not used in calculation. By default, this setting is empty.

### 4.8.3 Calibration

Calibration	
Property	Value
TempCoef	25.3719;-0.0308535;2.82503...
C1R1Coef	0;0;-0.770343;0.018805;-4.3...
C1R2Coef	0;0;0;1;0;0
C1R3Coef	0;0;0;1;0;0
C1R4Coef	0;0;0;1;0;0
C2R1Coef	0;0;0;1;0;0
TSSCoef	0;1;0;0;0;0

Figure 4-24: Calibration coefficients in User Maintenance

The **Calibration** section contains 7 sets of calibration coefficients and settings. Except from the **TSSCoef** these coefficients are calculated during a calibration process at the factory and are not recommended to change for other than trained personal at Aanderaa certified calibration laboratories.

**TempCoef** is a set of 6 coefficients used as curve fitting coefficient for temperature measurements. Together with **RawTemp** it is used to calculate the absolute temperature.

**C1R1Coef**, **C1R2Coef**, **C1R3Coef** and **C1R4Coef** is calculated after calibration at factory for each of the four ranges.

**C2R1Coef** is only for factory use and therefor write protected.

**TSSCoef** are used to convert the sensor reading to **TSS** based on local samples collected and filtered. See **chapter 8.1** for more info.

### 4.8.4 Sample Settings

Sample Settings	
Property	Value
TXReference Interval	1

Figure 4-25: Sample Settings in User Maintenance

**TXReference Interval**; this is a sample interval divisor for use of **TXReference**. When the value is set to **1** (default) the **TXReference** measurement is performed during each sample. The value can be increased to reduce power drain or to set a faster sampling interval, less than 2 sec. When the value is set to e.g. **10**, the **TXReference** measurement is only performed for each 10<sup>th</sup> sample.

## CHAPTER 5 Stand-alone Sensor configuration using Terminal Software

---

This chapter describes how to communicate with the Turbidity Sensor using the RS-232 connection and Terminal Software. The sensor can be set to any mode but the mode setting and setting of the different properties will influence on the output from the sensor.

### 5.1 Sensor versions and interface

The 4296 sensors can be used on a SeaGuardII and SmartGuard (AiCaP) Dataloggers or connected to a RS-232 com-port (PC or other devices with RS232 com-port or a serial to USB konverter).

### 5.2 Communication setup

Most terminal programs can be used for **RS-232** communication with the sensor when connected to a PC, e.g. TeraTerm.

The following setup should be used:

- 9600 Baud
- 8 Data bits
- 1 Stop bit
- No Parity
- Xon/Xoff Flow Control

***IMPORTANT! The terminal program must send a Line Feed after each Carriage Return.***

***Note! If using Tera Terminal Pro, after setting up the com port according to settings above please select “Terminal” in the “Set up” menu and click “Local echo” also select “CR+LF” for both “Receive” and “Transmit” under “New line”.***

***Note! If using Hyper Terminal the options “Send line ends with line feeds” and “Echo line ends with line feeds” in the HyperTerminal ASCII setup must be selected.***

### 5.3 Sensor startup

You will be able to communicate with the sensor via the Terminal software regardless of which mode the sensor is set to. However, the output string from the sensor will depend on the mode setting. The final structure of the output string will also depend on settings like Enable Text, Enable Decimal Format, Enable Raw Data, and so on. In Smart Sensor Terminal and AADI Real-Time mode the sensor will continue to output measurements after the first startup info. The output frequency will be according to the interval setting. Some properties will not have any effects in all modes but they will still be available. Some properties may also have different effects depending on the mode.

### 5.3.1 Smart Sensor Terminal mode

In Smart Sensor Terminal the sensor will output *StartupInfo* with *Product Number*, *Serial Number*, *Mode*, *Protocol Version* and *Config Version*. It will also output a first measurement immediately after power-up and then a new measurement every x seconds, where x is the interval in second set by Interval(x).

```

%
StartupInfo      4296   35   Mode   AADI Smart Sensor Terminal Protocol   RS232 Protocol Version 3   Config
Version         1
MEASUREMENT     4296   35   Turbidity[LFTU] 1.167208E+02   Temperature[Deg.C] 2.540293E+01   TXCAmp[mU]
4.613339E+03    C1Amp[mU] 4.649856E+03    C2Amp[mU] 4.746766E+02   RawTemp[mU] -1.007080E+00
MEASUREMENT     4296   35   Turbidity[LFTU] 1.170080E+02   Temperature[Deg.C] 2.540138E+01   TXCAmp[mU]
4.618195E+03    C1Amp[mU] 4.649862E+03    C2Amp[mU] 4.741782E+02   RawTemp[mU] -9.567261E-01

```

Figure 5-1: Typical power-up output for sensor set to Smart Sensor Terminal mode

### 5.3.2 AiCaP mode

In *AiCaP* mode the sensor will output *StartupInfo* with *Product Number*, *Serial Number*, *Mode*, *AiCaP Version*, *Protocol Version* and *Config Version*. In this mode the sensor will not output any measurement since it needs an Aanderaa Datalogger as Master. The sensor can be configured for *AiCaP* use via the Terminal software.

```

File Edit Setup Control Window Help
%
StartupInfo      4296   35   Mode   AiCaP   CANID   0x187DEE00   AiCaP Version 0   RS232 Protocol Version
3   Config Version 1
Trying to connect to CANbus network

```

Figure 5-2: Typical power-up output for sensor set to AiCaP mode

### 5.3.3 AADI Real-Time mode

*AADI Real-Time* mode is also a Serial output but with xml instead of ASCII. This is the mode used with *AADI Real-Time Collector* and also preferred by some integrators when sensor is connected to 3rd party loggers or interface.

```

File Edit Setup Control Window Help
%
<<+!000000BEEF360=4296-35;1=4296;2=35;3=Turbidity Sensor;4=Turbidity Sensor #35;5=AADI;6=2;7=3;10=1;11=6.0;20=1;21
=1;22=0;23=5000;30=1;80=102:110:111:140:201:202:203FF84!!--><<+!0001109020?xml version="1.0" encoding="utf-8"?>
<Device ID="4296-35" SessionID="4296-35-5.5.2-0-314" Descr="Turbidity Sensor #35" SerialNo="35" ProdNo="4296" ProdName
="Turbidity Sensor" DeviceType="Sensor" ProtocolVer="6" xmlns="http://www.aadi.no/RIOutSchema">
  <Time>1900-01-01T00:00:00Z</Time>
  <StatusCode>0</StatusCode>
  <Notifications>
    <Notification ID="100" Time="1900-01-01T00:00:00Z">
      <Info>Power up</Info>
      <NotificationValues>
        <NotificationValue ID="0" Descr="Reason" Type="UT_I2">0</NotificationValue>
        <NotificationValue ID="1" Descr="DeviceReady" Type="UT_BOOL">true</NotificationValue>
      </NotificationValues>
    </Notification>
  </Notifications>
</Device>E62B!!-->

```

Figure 5-3: Typical power-up output for sensor set to AADI Real-Time mode

## 5.4 Controlling communication

In order to minimize the current drain the sensor normally enters a power down mode after each sampling; the sensor can be awake by any characters on, and will stay awake for a time set by the **Comm TimeOut** property after receiving the last character.

If the property **Comm TimeOut** is set to other than '**Always On**' the serial interface will not be activated after power-up (or the **Reset** command). Any character will activate the serial interface, but a Carriage Return (CR or CR+LF), '/' or ';' are often preferred since these characters do not interfere with the command syntax. The serial interface will then be active until a period of input inactivity specified by the **Comm TimeOut** value. The **Communication Sleep Indicator**, '%', will be transmitted when the serial communication is deactivated, and the **Communication Ready Indicator**, '!' is outputted subsequent to activation (electronics require up to 500ms start up time). When **Comm TimeOut** is set to '**Always On**' the communication (and microprocessor) will be kept active all time. The **Communication Sleep Indicator** '%' and the **Communication Ready Indicator** '!' are not followed by Carriage Return and Line Feed.

Any character will cause the electronics to return to normal operation; when the sensor has responded with the character '!', new commands may be entered.

When communicating with the sensor, you must start by pressing *Enter*. The sensor will respond in two ways (**Comm TimeOut** is 1 minute by default in the following description):

- If the sensor is ready for communication, it will not send any response indicator. The sensor will stay awake and ready to receive commands for 1 minute
- If the sensor is in sleep mode and not ready for communication, the sensor will send a 'communication ready' indicator (!) when awakened (within 500ms). The sensor will then be ready for communication.

The '**Communication Sleep Indicator** %' and the '**Communication Ready**' Indicator '!' are not followed by Carriage Return and Line Feed.

## 5.5 Description of protocol

All inputs to the sensor are given as commands with the following format:

- **MainCmd SubCmd** or **MainCmd Property(Value, ..., Value)**

Eg. **Do Sample** or **Set Interval(10)**

Description of ASCII coded communication rules:

- The main command, **MainCmd**, is followed by an optional subcommand (**SubCmd**) or sensor property (**Property**).
- The **MainCmd** and the **SubCmd/Property** must be separated with the space ' ' character.
- When entering new settings the **Property** is followed by a parenthesis containing comma-separated values.
- The command string must be terminated by Carriage Return and Line Feed (ASCII code 13 & 10).
- The command string is not case sensitive (UPPER/lower-case).

- The ENUM property settings are case sensitive. E.g. “**Set Mode(AiCaP)**” Here AICAP will result in argument error.
- A valid command string is acknowledged with the character ‘#’ while character ‘\*’ indicates an error. Both are followed by Carriage Return/ Line Feed (CRLF).
- For most errors a short error message is also given subsequent to the error indicator.
- There are also special commands with short names and dedicated tasks, as **save**, **reset**, and **help**.
- All names and numbers are separated by tabulator spacing (ASCII code 9).
- The string is terminated by Carriage Return and Line Feed (ASCII code 13 & 10).

*Note! Losing power during the flashing process can cause corruption of vital settings, such as coefficients, serial number, model number etc. If losing settings, contact AADI Service department for new setting file for the specific sensor with further instructions.*

## 5.6 Passkey for write protection

To avoid accidental change of the sensor configuration, most of the properties are write-protected. There are five levels of access protection, refer **Table 5-1**.

A special property called *Passkey* must be set according to the protection level before changing the value of properties that are write-protected, refer **Table 5-1**. E.g.:

**Set passkey(1000)**

**Table 6-1 Access protection levels**

Output	Passkey	Description
No		No Passkey needed for changing property
Low	1	The Passkey must be set to 1 prior to changing property
High	1000	The Passkey must be set to 1000 prior to changing property This Passkey value also give read access to factory properties that usually are hidden
Read Only		The user have only read access, no passkey needed
Factory Write	XXXX	Sensor specific code for factory level access

After a period of inactivity at the serial input, the access level will revert to default. This period corresponds to the **Comm TimeOut** setting, or 1 minute if the **Comm TimeOut** is set to **Always On**.

## 5.7 Save and Reset

When the required properties are set, you must send a **Save** command to make sure that the new configuration are saved internally in the flash memory. The Turbidity Sensor always reads the configuration from the internal flash memory after reset and power up.

When changing the *Mode* and *Baudrate* property a reset is required for the change to take effect.

The **Save** command takes a few seconds to complete (indicated with the character '#').

Always send a **Reset** command when a new configuration has been saved (or switch the power OFF and then back ON), or else calculated parameters may be corrupted. This forces the sensor to start up with the new configuration input. If the **Enable Sleep** property is set to **Yes** and the **Comm TimeOut** property is not set to **Always On** the sensor enters sleep mode after reset.

## 5.8 Available Commands for the Turbidity Sensor

Available commands and properties for the Turbidity Sensor are given in Table 7-1 and Error! Reference source not found. respectively.

**Table 6-2 Main RS232 commands available for the Turbidity Sensor.**

Command	Description
Do Sample	Execute an turbidity measurement and presents the result
Start	Start a measurement sequence according to current configuration
Stop	Stop a measurement sequence
Get <i>ConfigXML</i>	Outputs info on available properties on XML format
Get <i>DataXML</i>	Outputs info on available(enabled) parameters on XML format
Get <i>Property</i>	Output Property value
Get All	Output all property values
Set <i>Property(Value,.. Value)</i>	Set Property to Value,... Value
Set <i>Passkey(Value)</i>	Set passkey to change access level
Save <sup>1)</sup>	Store current settings
Load	Reloads previous stored settings
Reset	Resets the sensor with new configuration
Help	Print help information
;	Comment string, following characters are ignored
//	Comment string, following characters are ignored

1) Note that the Save procedure might require up to 20 seconds. Losing power during this period will cause loss of latest configuration change. Wait for acknowledge, '#', before powering down the sensor.

### 5.8.1 The Get command

The **Get** command is used to read the value/values of a property and to read the latest value of a parameter.

The command name **Get** followed by a **Property** returns a string in the following format:

*Property ProductNo SerialNo Value, ..., Value*

The string starts with the name of the property, the product number and serial number of the sensor, and finally the value of the property.

```

File Edit Setup Control Window Help
get product number
Product Number 4296 35 4296
#
get serial number
Serial Number 4296 35 35
#
get mode
Mode 4296 35 AADI Real-Time
#
get interval
Interval 4296 35 5.000000E+00
#

```

The command name **Get** followed by a parameter returns the name and unit of the parameter, the product and serial number of the sensor, and finally the latest parameter reading.

Figure 5-4: The Get Command

```

File Edit Setup Control Window Help
get all
Product Name 4296 35 Turbidity Sensor
Product Number 4296 35 4296
Serial Number 4296 35 35
SW ID 4296 35 1940007
SW Version 4296 35 5 5 2
Range 4296 35 1
Node Description 4296 35 Turbidity Sensor #35
Owner 4296 35
Mode 4296 35 AADI Real-Time
Enable Sleep 4296 35 Yes
Enable Polled Mode 4296 35 No
Enable Text 4296 35 Yes
Enable Decimalformat 4296 35 No
Enable Rawdata 4296 35 Yes
Enable Temperature 4296 35 Yes
Enable ISS 4296 35 No
Intervals1 4296 35 5.000000E+00
Location 4296 35
Geographic Position 4296 35 60.323605,5.37225
Vertical Position 4296 35
Reference 4296 35
#
set passkey(1000)
#
get all
Product Name 4296 35 Turbidity Sensor
Product Number 4296 35 4296
Serial Number 4296 35 35
SW ID 4296 35 1940007
SW Version 4296 35 5 5 2
HW ID 1 4296 35 3969315
HW Version 1 4296 35 Rev3
HW ID 2 4296 35 3969316
HW Version 2 4296 35 Rev4

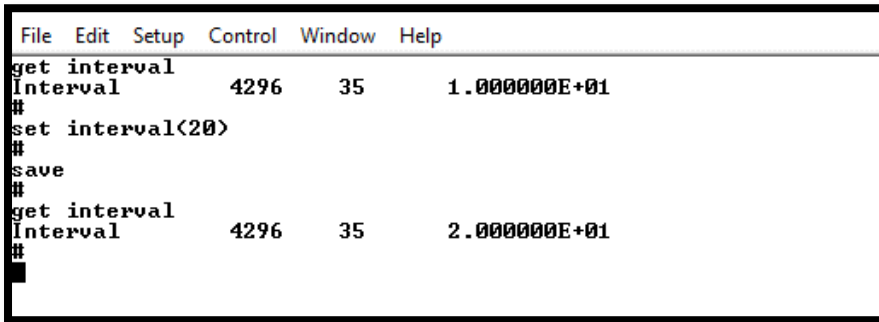
```

A special version, **Get All**, reads out all available properties in the sensor. Some properties are passkey protected and will not be shown without first writing the passkey. To see all user accessible properties, use passkey **1000**.

Figure 5-5: Get all



## 5.8.2 The Set command



```
File Edit Setup Control Window Help
get interval
Interval      4296    35      1.000000E+01
#
set interval<20>
#
save
#
get interval
Interval      4296    35      2.000000E+01
#
```

The **Set** command is used for changing a property. The corresponding **Get** command can be used to verify the new setting, as shown in [Figure 6-7](#).

Figure 5-6: The Set Command

Use the **Save** commands to permanently store the new property value. Remember to always wait for the acknowledge character '#' after a save before switching off power to the sensor. If the power is lost while saving, the previous configuration saved to flash is used by the sensor.

The **Mode** and **Baudrate** property will require a **Reset** before the change is executed. All other property changes will be executed immediately.

## 5.8.3 XML commands

The **Get ConfigXML** command outputs all available sensor properties in XML-format.

The **Get DataXML** command outputs all available sensor parameters in XML-format.

The **XML-output** is a general format shared by all Aanderaa smart sensors; the output from different types of smart sensors can be read and presented as e.g. in a general smart sensor setup program.

## 5.8.4 Formatting the Output String

The property called **Enable Text** controls the presentation of measured data. When the property is set to **(Yes)** the output string includes the descriptive parameter name. When the property is set to **(No)**, the output parameters are presented without descriptive parameter names; the parameter order is the same.

The property called **Enable DecimalFormat** controls the format of the output values, either as decimal numbers **(Yes)**, or in exponential format **(No)**.

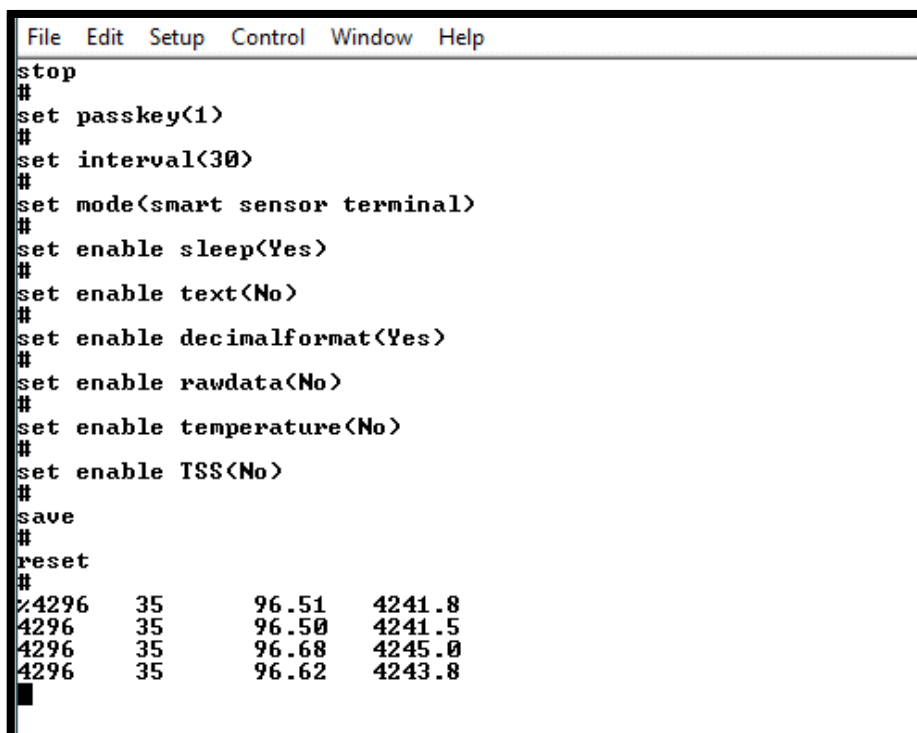
## 5.8.5 Examples – How to configure sensor with Terminal Software

In the following examples, we will show you several configuration changes. We recommend using **Stop** if using a short interval to avoid output strings while configuring the sensor. If the sensor has started to transmit data when the user tries to communicate, it may take a few seconds before the sensor respond. This depends on the number of enabled parameters.

Example 1: In this example we turn of all parameters that are selectable and end up with a clean and simple ASCII output that is easy to use if you need to transmit the data using communication with limited bandwidth. It's then also easy to add other parameters like Temperature by sending **Set Enable Temperature(Yes)** to the sensor.

The output is: **Product Number Serial Number Turbidity[FTU] TXCAmp[mV]**

```
//Press Enter to start communicating with the sensor.
↵ //press Enter
Stop ↵//Wait for ack #. Repeat if necessary
Set Passkey(1) ↵
Set Interval(30) ↵//wait for ack #
Set Mode(Smart Sensor Terminal) ↵//wait for ack #
Set Enable Sleep(Yes) ↵//wait for ack #
Set Enable Text(No) ↵//wait for ack #
Set Enable Decimalformat(Yes) ↵//wait for ack #
Set Enable Rawdata(No) ↵//wait for ack #
Set Temperature(No) ↵//wait for ack #
Set Enable TSS(No) ↵//wait for ack #
Save ↵// wait for ack #
Reset ↵// the sensor will restart with new settings
```



```
File Edit Setup Control Window Help
stop
#
set passkey<1>
#
set interval<30>
#
set mode<smart sensor terminal>
#
set enable sleep<Yes>
#
set enable text<No>
#
set enable decimalformat<Yes>
#
set enable rawdata<No>
#
set enable temperature<No>
#
set enable TSS<No>
#
save
#
reset
#
%4296 35 96.51 4241.8
4296 35 96.50 4241.5
4296 35 96.68 4245.0
4296 35 96.62 4243.8
█
```

Figure 5-7: Example 1

Example 2 is the oposite of Example 1. Here all selectable parameters and text is enabled. Decimal format is deselected and we end up with a output string with

**MEASSUREMENT Product Number Seial Number Turbidity TSS(mg/l) Temp...**

```
//Press Enter to start communicating with the sensor.
↵ //press Enter
Stop ↵//Wait for ack #. Repeat if necessary
et Passkey(1) ↵
Set Interval(10) ↵//wait for ack #
Set Mode(Smart Sensor Terminal) ↵//wait for ack #
Set Enable Sleep(Yes) ↵//wait for ack #
Set Enable Text(Yes) ↵//wait for ack #
Set Enable Decimalformat(Yes) ↵//wait for ack #
Set Enable Temperature(Yes) ↵//wait for ack #
Set Enable Rawdata(Yes) ↵//wait for ack #
Set Enable TSS(Yes) ↵//wait for ack #
Save ↵// wait for ack #
Reset ↵// the sensor will restart with new settings
```

```
File Edit Setup Control Window Help
stop
#
set passkey(1)
#
set interval(10)
#
set mode(Smart Sensor Terminal)
#
set enable sleep(Yes)
#
set enable text(Yes)
#
set enable decimalformat(Yes)
#
set enable temperature(Yes)
#
set enable rawdata(Yes)
#
set enable TSS(Yes)
#
save
#
reset
#
%
StartupInfo      4296   35   Mode   AADI Smart Sensor Terminal Protocol   RS232 Protocol Uersion   3   Config Uersion
1
MEASUREMENT      4296   35   Turbidity[FTU]  90.98   TSS[mg/l]   90.98   Temperature [Deg.C]  25.033   TXCAmp[mU]
4127.6 C1Amp[mU]  4159.2  C2Amp[mU]  474.5   RawTemp[mU]  11.0
MEASUREMENT      4296   35   Turbidity[FTU]  13.97   TSS[mg/l]   13.97   Temperature [Deg.C]  25.037   TXCAmp[mU]
932.7 C1Amp[mU]   939.3   C2Amp[mU]  474.3   RawTemp[mU]  10.9
MEASUREMENT      4296   35   Turbidity[FTU]  13.80   TSS[mg/l]   13.80   Temperature [Deg.C]  25.040   TXCAmp[mU]
920.7 C1Amp[mU]   927.5   C2Amp[mU]  474.4   RawTemp[mU]  10.8
MEASUREMENT      4296   35   Turbidity[FTU]  16.40   TSS[mg/l]   16.40   Temperature [Deg.C]  25.044   TXCAmp[mU]
1108.7 C1Amp[mU]  1118.2  C2Amp[mU]  475.0   RawTemp[mU]  10.6
```

Figure 5-8: Example 2

### 5.9 Help command output

The available/selectable values for each enumerated property can be found by sending the command **Help**. This gives a printout from the sensor showing a short help text from the sensor. Setting a value which is not shown here for enumerated properties gives an error message (\*ERROR ARGUMENT ERROR).

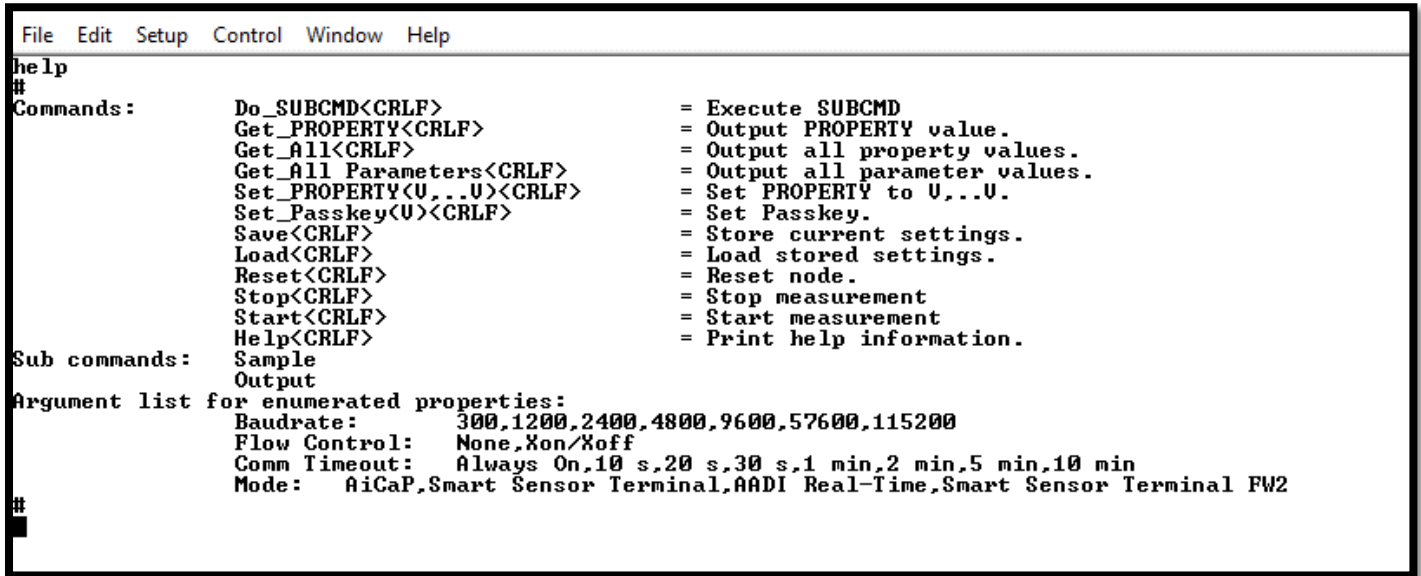


Figure 5-9: Output example from the Help command

```

Commands:
Do_SUBCMD<CRLF>          = Execute SUBCMD
Get_PROPERTY<CRLF>      = Output PROPERTY value.
Get_All<CRLF>           = Output all property values.
Get_All Parameters<CRLF> = Output all parameter values.
Set_PROPERTY(V,..V)<CRLF> = Set PROPERTY to V,..V.
Set_Passkey(V)<CRLF>    = Set Passkey.
Save<CRLF>             = Store current settings.
Load<CRLF>             = Load stored settings.
Reset<CRLF>            = Reset node.
Stop<CRLF>             = Stop measurement
Start<CRLF>           = Start measurement
Help<CRLF>            = Print help information.
Sub commands:
Sample
Output
Argument list for enumerated properties:
Baudrate:     300,1200,2400,4800,9600,57600,115200
Flow Control: None,Xon/Xoff
Comm Timeout: Always On,10 s,20 s,30 s,1 min,2 min,5 min,10 min
Mode:         AiCaP,Smart Sensor Terminal,AADI Real-Time, Smart Sensor
Terminal FW2

```

### 5.10 Scripting -sending a string of commands

Often it may be usefully to collect more than one command in a text file. For example the instructions below can be written in an ordinary text editor and saved as a text file, which can be sent to the sensor. In HyperTerminal click *send text file* in the *Transfer* menu and select the correct file. In Tera Terminal click “Send File” under “File” in main menu and select the file to be transferred.

Example of text file:

// Set sampling interval to 30 seconds.

**Set Passkey(1)**

**Set Interval(30)**

**Save**

**Get All**

**NOTE! The last line, Get All, reads out available properties for the sensor.**

The first line is a comment line that is disregarded by the sensor. Strings starting with either ‘//’ or ‘;’ are ignored by the software, and do not produce errors or acknowledgements. When sending text file the sensor can be awakened from sleep mode by sending a string of comment leads characters:

```
////////////////////////////////////  
////////////////////////////////////  
////////////////////////////////////
```

**// Wake up test**

**Get All**

This will provide time for the Turbidity Sensor to wake up and be ready before the next string appears. Note that higher baud rates might require more lines of ‘/’ to provide sufficient delay. Communication wake-up will normally require less than 100mS.

## 5.11 Sensor Configuration

The sensor configuration consists of sensor settings and customized presentation of data. Below follows a description of the properties that are typically set by the user prior to a deployment (RS232 application)..

The **Mode** property is used to set the operation mode. Available modes are **AiCaP**, **Smart Sensor Terminal**, **AAID Real-Time** and **Smart Sensor Terminal FW2**.

- Set **Mode** to '**AiCaP**' when connected to AADI SeaGuard or to a SmartGuard logger that automatically detects and recognizes the sensor on CANbus(AiCaP).
- Set **Mode** to '**AAID Real-Time**' for use with AADI Real-Time Data Collector or third-party software that can handle XML based protocol
- Set **Mode** to '**Smart Sensor Terminal**' for a simple ASCII command string-based protocol when connected to PC or third-party serial interface
- Set **Mode** to **Smart Sensor Terminal FW2** when sensor output needs to be compatible with older sensors.

**Note! As default the 4296 sensors are set to AiCaP communication. Please select the correct Output according to which type of logger/interface you plan to use.**

Set the **Enable TSS**, **Enable Temperature**, and **Enable Rawdata** to **(Yes)** to include these parameters in the output string.

**Enable TSS**, enables the calculation of **TSS** based on the coefficients stored in **TSSCoef**. See **chapter 8.1** for more info about this measurement.

**Enable Temperature**. This setting is used to enable or disable the **Temperature** output. The temperature reading is used to compensate for internal temperature drift when turbidity level is calculated independently of this setting.

**Enable Rawdata**. This setting toggles on and off a set of raw data readings from the serial output string. These raw data readings are used internally in the calculation independently of this setting. The parameters are:

- C1Amp(mV): Amplitude measurement with
- C2Amp (mV): Amplitude measurement with
- RawTemp(mV): Voltage from Thermistor Bridge.

Set the **Enable Text** to **(Yes)** for the Turbidity Sensor to output a detailed text string with the measurements, or **(No)** to output the measured values without the descriptive text.

Set the **Enable Decimalformat** to **(Yes)** to output the measured values in decimal format. Set the property to **(No)** to output the values in exponential format (higher resolution in the output parameter value).

The **Interval** property describes the measurement interval in seconds; the Turbidity Sensor provides a set of measured data for every measurement interval.

If the **Enable Polled Mode** is enabled, then the sensor only outputs data when the user/system polls for data with a **Do Sample** command.

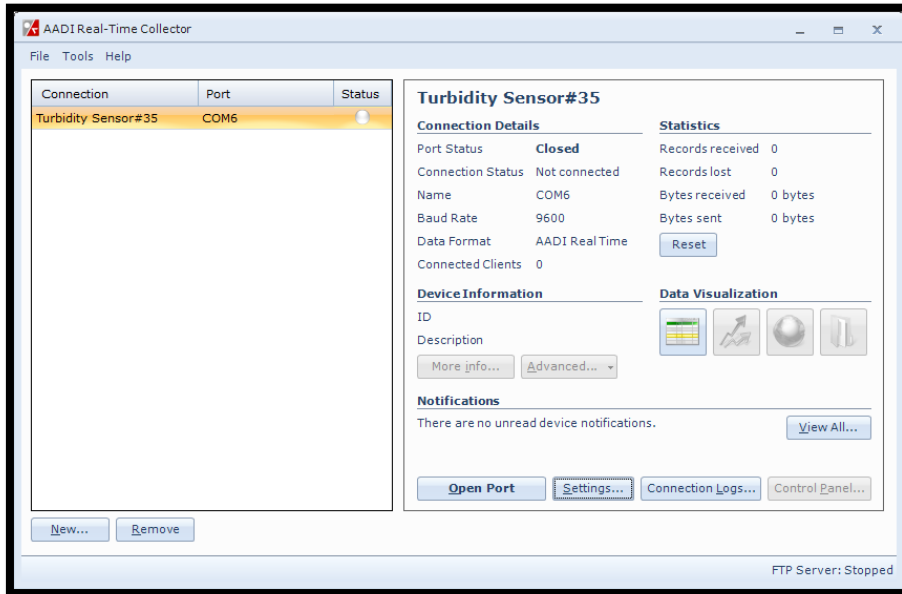
Set the **Enable Sleep** to (**Yes**) for the sensor to go to sleep between recordings, or (**No**) for the sensor to stay continuously switched *on* between recordings (drains more power).

# CHAPTER 6 *Logging data via AADI Real-Time Collector*

## 6.1 Logging data on PC

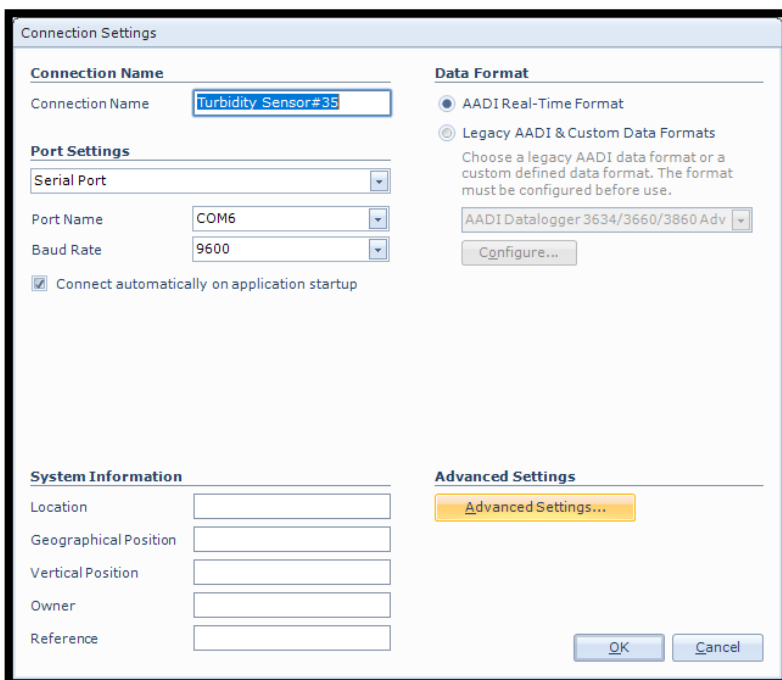
The **AADI Real-Time Collector** can save the incoming data to file if the sensor is in **AADI Real-Time** mode, either to a txt-file or to xml-files.

### 6.1.1 Enabling file output



If your connection is open, status is green in the **AADI Real Time Collector** main menu close the port first to be able to change the file output settings. Click on the connection you are using. Then click on the **“Settings...”** button.

Figure 6-1: AADI Real-Time Collector start up menu



Then click on the **“Advanced Settings...”** button in the **Connection Settings** window.

Figure 6-2: Connection settings menu



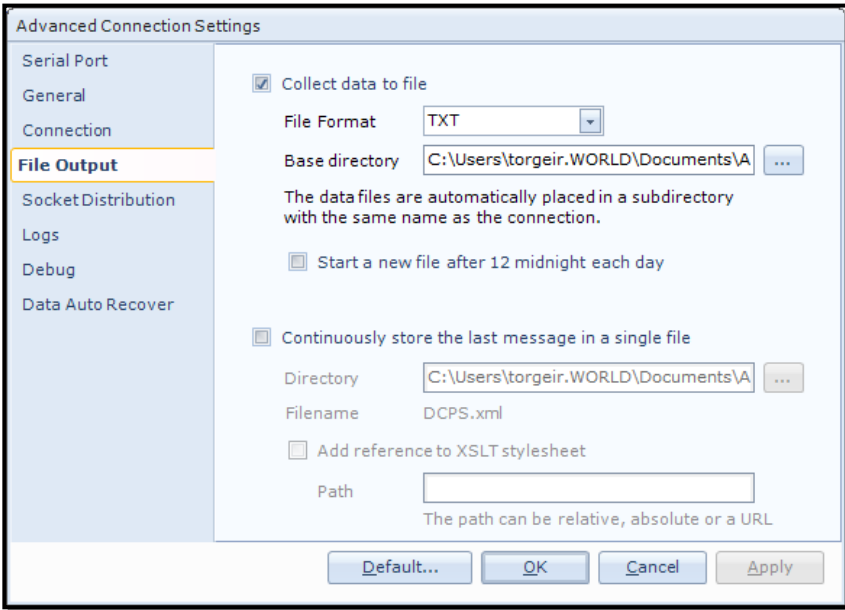


Figure 6-3: Advanced connection settings / File Output

Choose **File Output** from the list on the left side. Check the **“Collect data to file”** box to enable file output. Select a file format either XML or TXT and choose a base directory where you want the file to be saved.

Alternatively, you may select **“Continuously store the last message in a single file”** if you want to continuously store the last message in a single file. Click **“OK”** in the **Advanced Connection Settings** window, and **“OK”** in the **Connection Settings** window.

### 6.1.2 Starting the sensor and logging to file

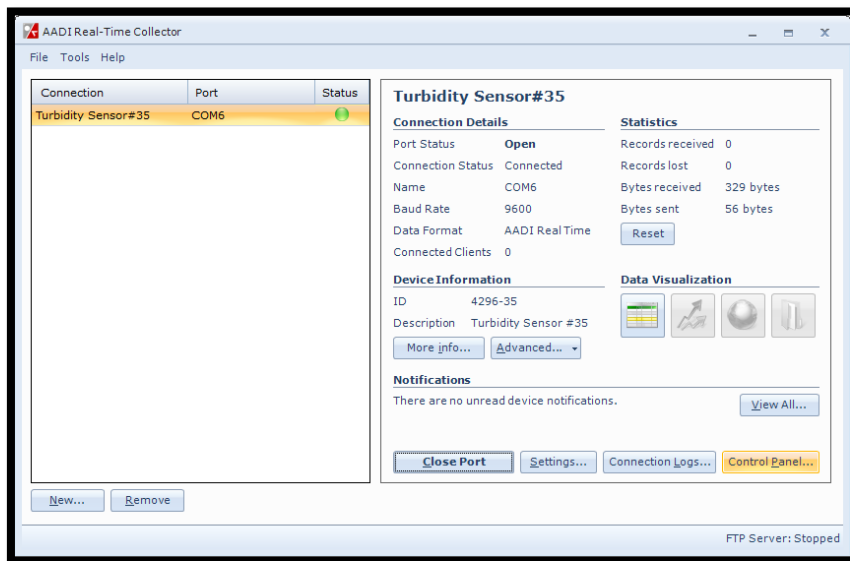
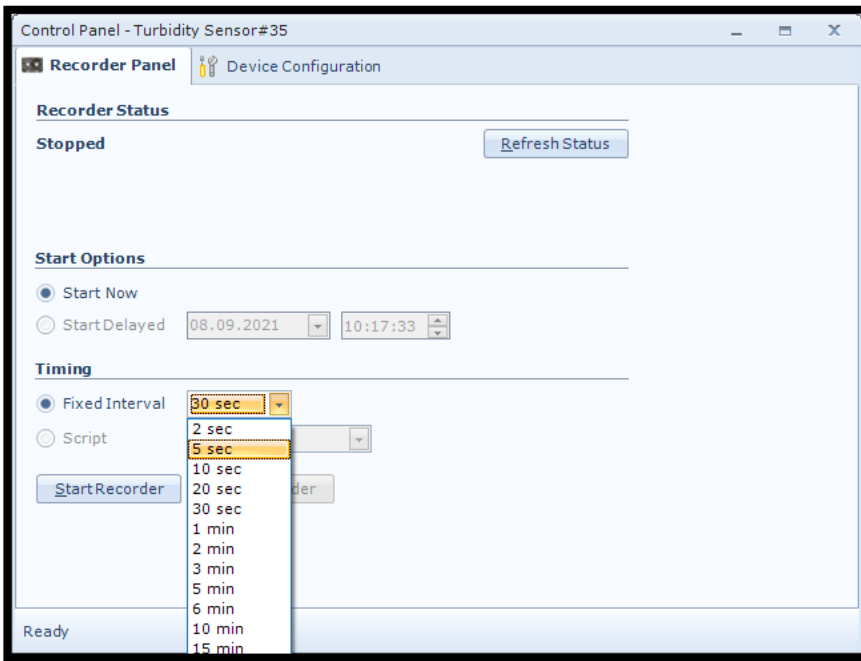


Figure 6-4: AADI Real-Time Collector start up menu

Select your connection in the connection list and then press **“Open Port”**. The Status turns green when the sensor is connected.

Click on the **“Control Panel...”** button in the lower right corner.



Select the interval duration and click the “**Start Recorder**” button. This configuration is only available if the sensor is in **AADI Real-Time** mode.

Figure 6-5: Recorder panel

Data will start logging in the defined directory. If it is a txt-file, the easiest way to view it is in Excel. **Figure 6-6** gives an example of obtained data file. The different parameters are organized in columns. This picture might be different if your sensor has a different configuration.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Description	Turbidity Sensor #35														
2	Product Name	Turbidity Sensor														
3	Product Number	4296														
4	Serial Number	35														
5	Device ID	4296-35														
6	Session ID	4296-35-5.5.1-0-306														
7	Location															
8	Geographic Position	60.323605,5.37225														
9	Vertical Position															
10	Owner															
11	Reference															
12																
13																
14		Turbidity Sensor #35														
15	Record Time	Record Num	Sensor Sta	Turbidity	Status	Temperat	Status	TXCAmp [	Status	C1Amp [m	Status	C2Amp [m	Status	RawTemp	Status	
16	08.09.2021 10:21	1	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.88E+01		
17	08.09.2021 10:21	2	(0)	OK	1.03E+02	2.62E+01		4.36E+03		4.38E+03		4.73E+02		-2.81E+01		
18	08.09.2021 10:21	3	(0)	OK	1.18E+02	2.62E+01		4.63E+03		4.65E+03		4.73E+02		-2.83E+01		
19	08.09.2021 10:21	4	(0)	OK	1.18E+02	2.63E+01		4.64E+03		4.65E+03		4.72E+02		-2.86E+01		
20	08.09.2021 10:21	5	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.88E+01		
21	08.09.2021 10:21	6	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.88E+01		
22	08.09.2021 10:22	7	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.89E+01		
23	08.09.2021 10:22	8	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.89E+01		
24	08.09.2021 10:22	9	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.89E+01		
25	08.09.2021 10:22	10	(0)	OK	1.18E+02	2.63E+01		4.63E+03		4.65E+03		4.73E+02		-2.89E+01		
26																

Figure 6-6: Example of a txt-file obtained from the sensor using RT Collector

## 6.2 Viewing incoming data in real-time

### 6.2.1 Display data using Connection log

When the sensor is running, the incoming data can be viewed under “**Connection Logs...**” in the main AADI Real-Time Collector menu, refer to *Figure 6-4*.

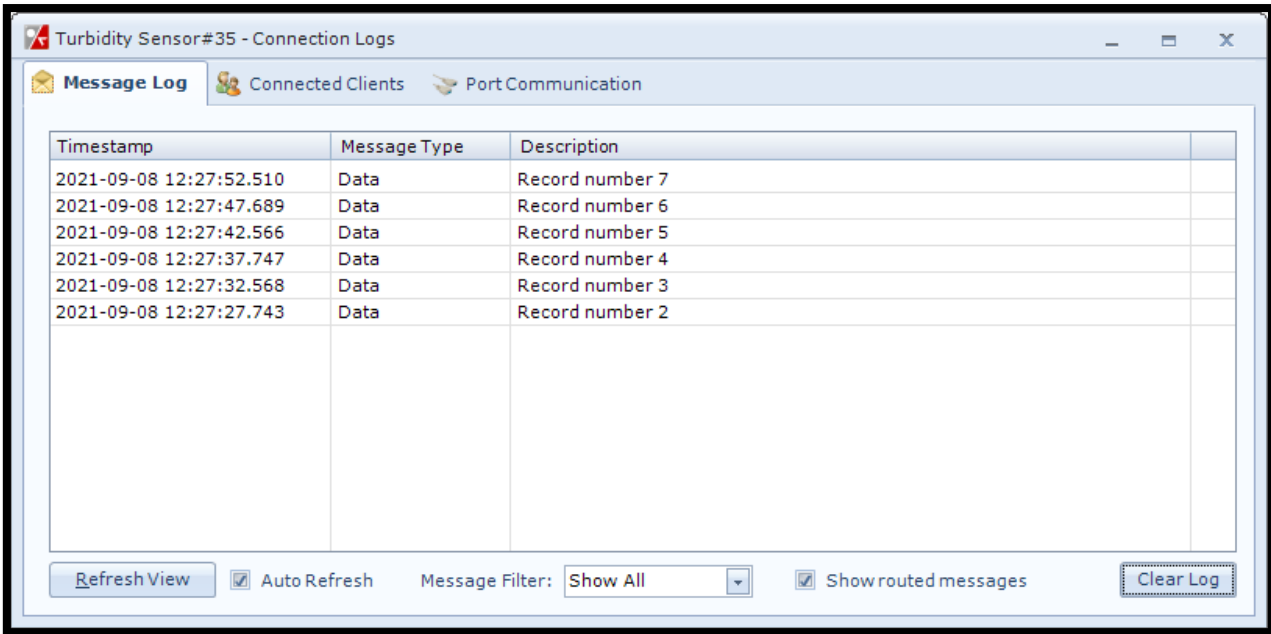


Figure 6-7: Connection Logs

Please note that this window is not automatically open, and you might need to go to the taskbar to open the window.

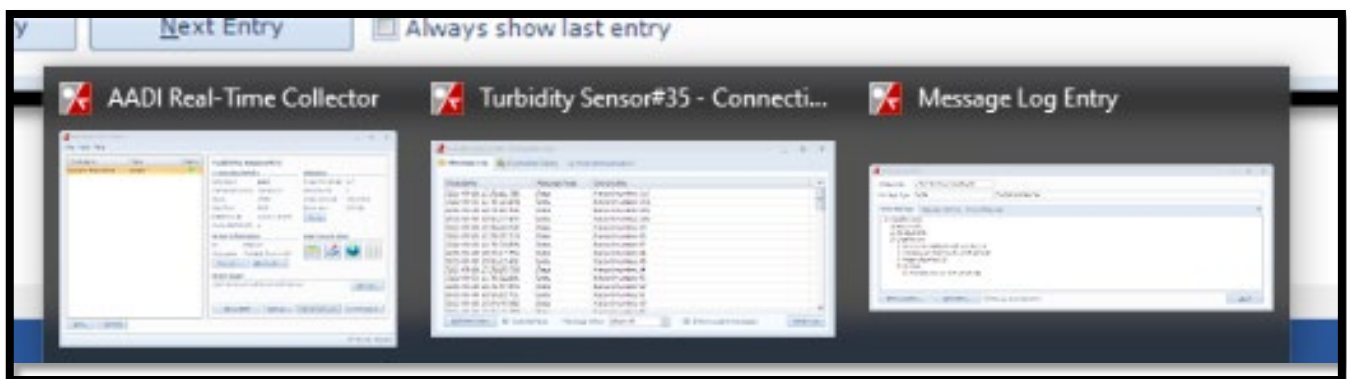


Figure 6-8: Task bar

Double-click on one of the Record numbers to look at the data.

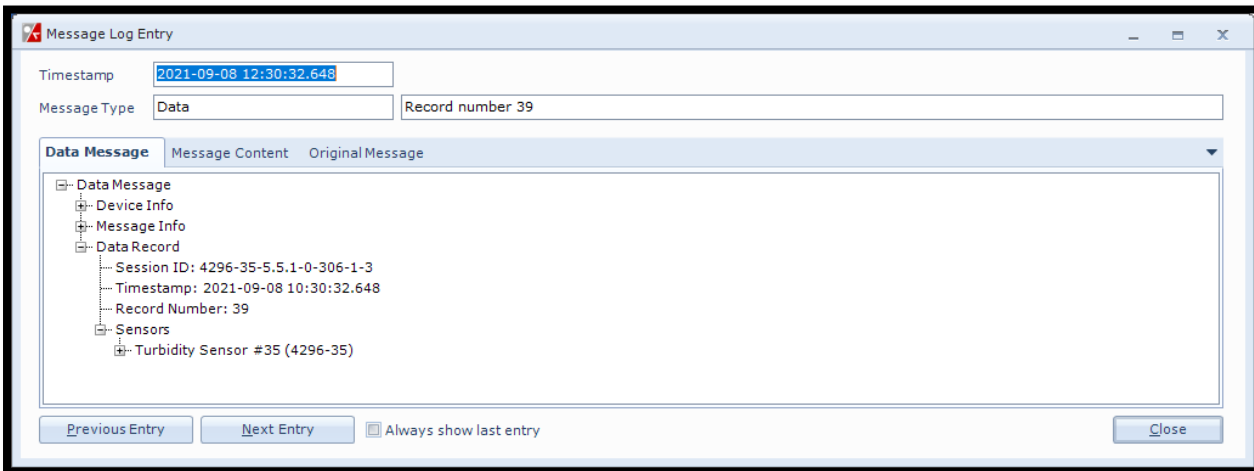


Figure 6-9: Message Log Entry

Click on the + signs to open and see all the data in the message. Some of the group also has under groups with more data. Measured data are found under **Point Parameters**.

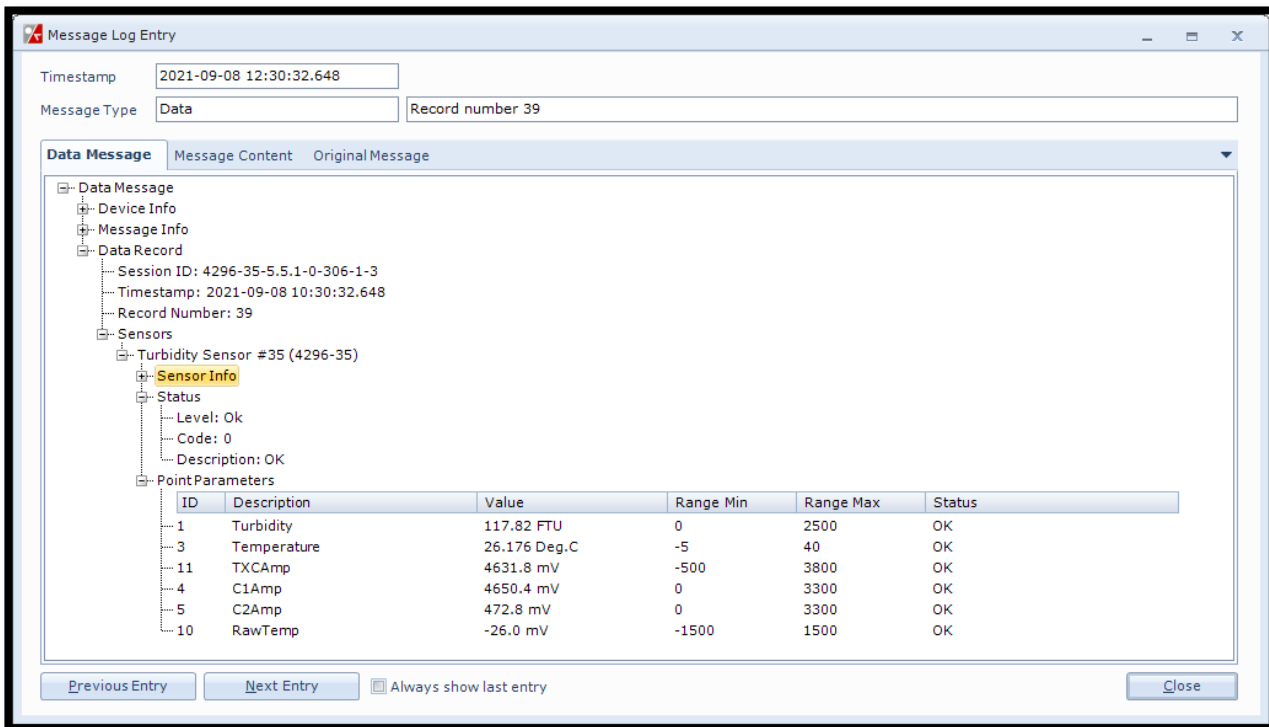


Figure 6-10: Visualization of incoming data from the sensor in real time

Previous records or newer records can be viewed by clicking on **Previous Entry** button or **Next Entry button**. An automatic update to the last data message can be enabled by checking the **Always show last entry** check box.

The original message content can be seen if clicking on the **Original Message** tab.

## 6.2.2 Display incoming data using Data Visualization

**AADI Real-Time Collector** also includes two other methods for showing incoming data in real-time as long as the sensor is set to **AADI Real-Time** mode and the recorder is running. These two tools are located on the start page under **Data Visualization**.

**Data Visualization** is used to show data either in a **Text Viewer** or **Chart Viewer**.

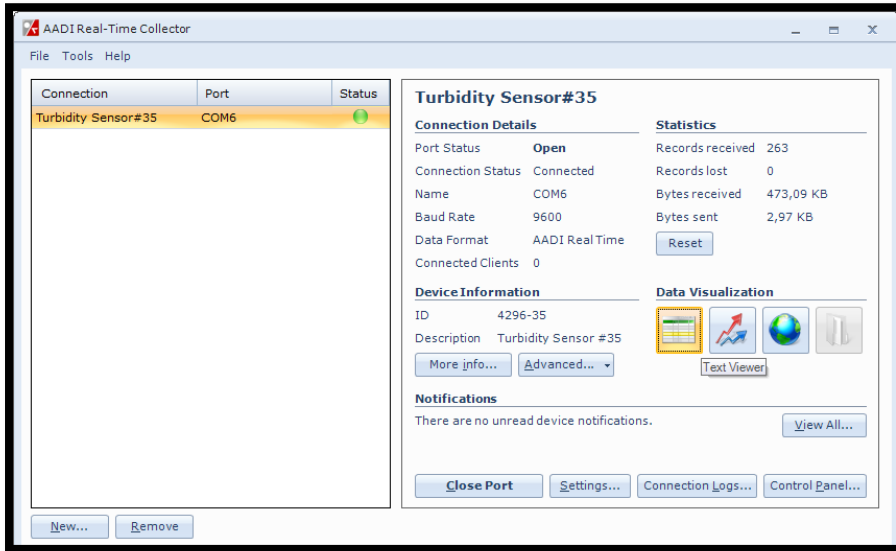


Figure 6-11: Data Visualization



Select the **Text Viewer** icon to show incoming data in a text format

Figure 6-12: Text Viewer icon

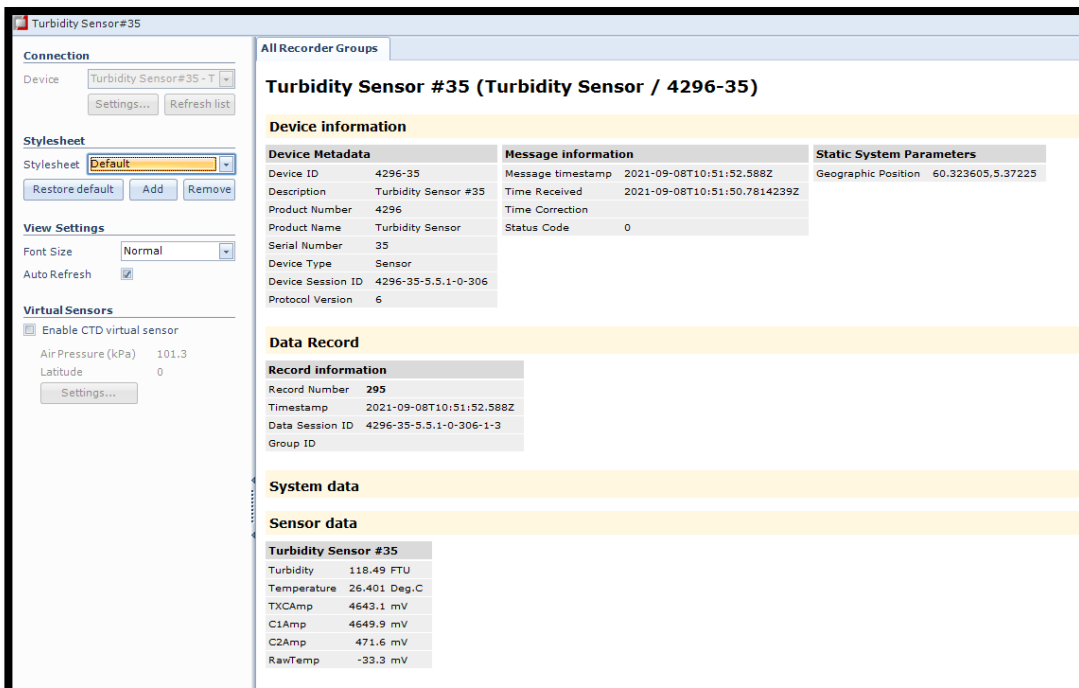


Figure 6-13: Text Viewer



Select the **Chart Viewer** icon to show the incoming data in a graph format.

Figure 6-14: Chart Viewer icon

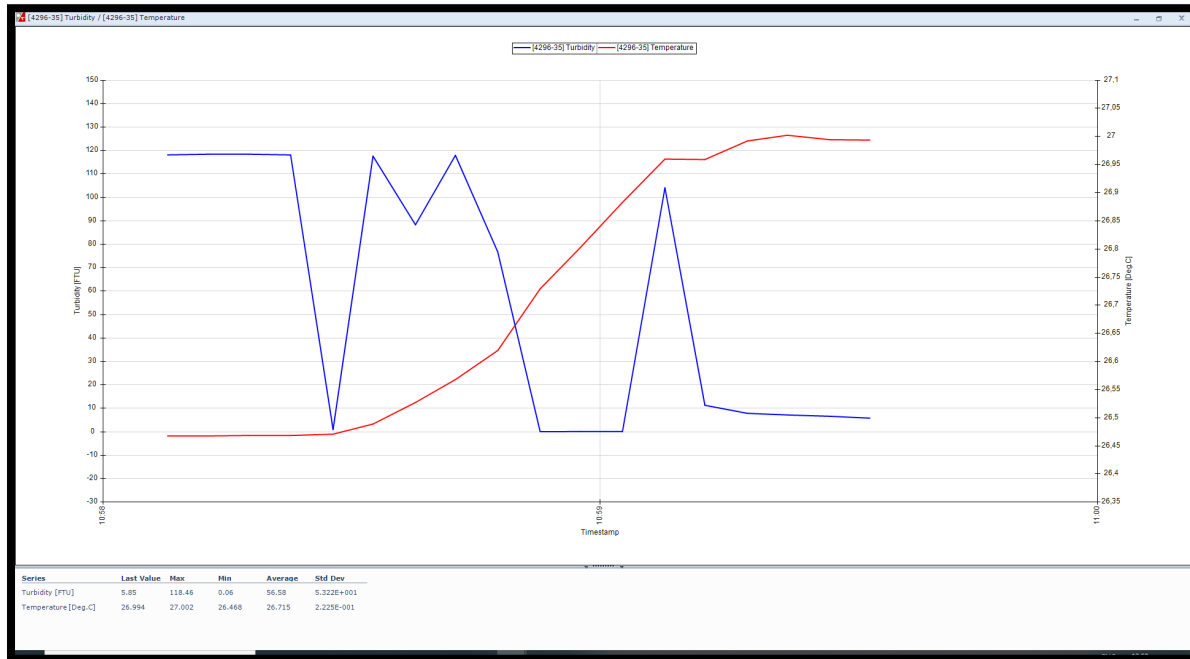


Figure 6-15: Chart Viewer

In the **Chart Viewer** you may select up to four parameters simultaneously. You can change the view by right click in the picture. Then you get access to zoom data and other control tools.

There is also a statistical summary of data in the lower left corner

## CHAPTER 7 Maintenance

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The Turbidity Sensor requires very little maintenance.

The sensor should be cleaned at regular intervals depending on the fouling condition at the site.

The Sensor housing can be cleaned using a brush and clean water.



Fouling consisting of calcareous organisms (e.g. barnacles), can be dissolved by dipping the sensor/instrument in a weak acid solution (e.g. 7% Vinegar) over night before cleaning.

If the sensing window is scratched the sensor will still work but might give bad readings due to spreading of the transmitted signal.

If severely damaged (so that the sensor gives unrealistic readings) the sensor need service at the factory

Annual recalibration is optimal and recommended by the factory. Although for many applications this may not be possible. In case where longer calibration intervals are expected use of a controlled reference can be adequate to QC the data.

Figure 7-1: Example of fouling on an RCM 9

### 7.1 Function Test

We recommend that you perform a function test of the sensor operating in air to verify the sensor readings. Refer chapter 7.1.1 for a description of the function test procedure.

Check the turbidity reading in air or in a water sample and check that the temperature sensor measurements are representative for the ambient temperature where its used.

### 7.1.1 Function test connected to SEAGUARD® with display

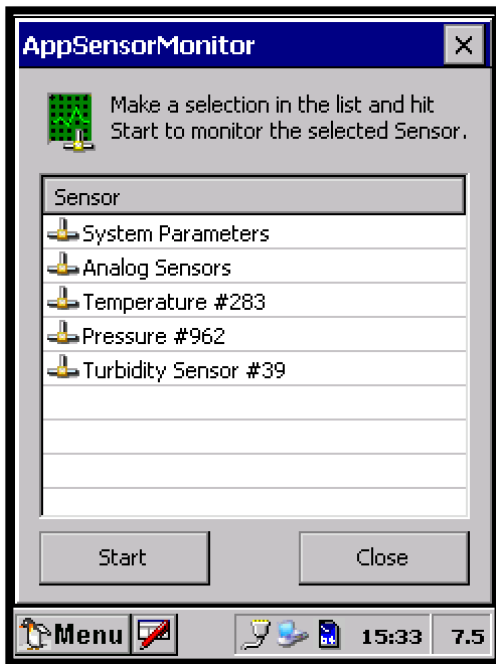


Figure 7-2: Select sensors to monitor

Leave the Turbidity Sensor 4296 mounted onto the SEAGUARD® Platform. Power the instrument; refer TD262a and TD262b for operating instructions.

Open **Administrative Tools-> Sensor Monitor**

**Sensor Monitor** can be used as a direct reading of the sensor; the function is mainly used for test purposes.

Select the Turbidity Sensor from the list and press **Start**, refer **Figure 7-2**.

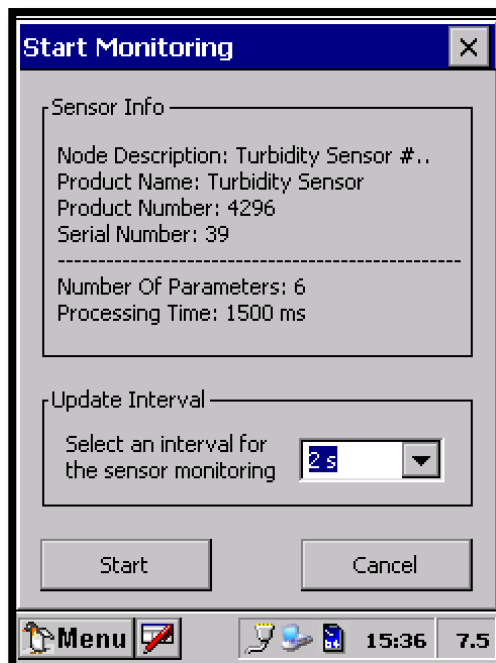


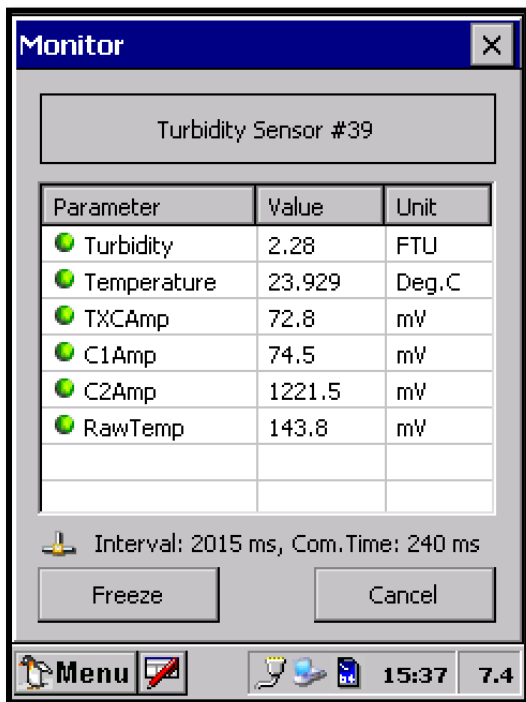
Figure 7-3: Set the Update Interval

The next window shows sensor information like the **Node Description, Product Name and Number, and Serial Number**, refer **Figure 7-3**.

The number of sensor parameters and the processing time can be viewed in the window.

Select an **Update Interval** for the sensor monitoring. Press **Start** to start monitoring the sensor readings.





The parameter reading in engineering units is shown as illustrated in **Figure 7-4**. The reading updates according to the update interval.

Press **Freeze** to temporarily stop the update; press **Start** to restart monitoring (**Start** is the same button as **Freeze**).

Press **Cancel** to stop monitoring.

The sensor readings should be according to you water sample or close to 0 in air. If you put a reflecting plate in front of the sensor approximately 5 cm away from the sensor the reading will increase.

**Figure 7-4: Monitor Sensor Readings**

## CHAPTER 8 Theory of Operation

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The Turbidity is an optical determination of water clarity. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Suspended solids and dissolved colored material reduce water clarity by creating an opaque, hazy or muddy appearance. Turbidity measurements are often used as an indicator of water quality based on clarity and estimated total suspended solids in water. The turbidity of water is based on the amount of light scattered by particles in the water column. The more particles that are present, the more light that will be scattered. As such, turbidity and total suspended solids are related. However, turbidity is not a direct measurement of the total suspended materials in water. Instead, as a measure of relative clarity, turbidity is often used to indicate changes in the total suspended solids concentration in water without providing an exact measurement of solids.

Turbidity can come from suspended sediment such as silt or clay, inorganic materials, or organic matter such as algae, plankton and decaying material. In addition to these suspended solids, turbidity can also include colored dissolved organic matter (CDOM), fluorescent dissolved organic matter (FDOM) and other dyes. Some dissolved substances may be too small to be counted in a suspended solids concentration, but they are still part of a turbidity measurement as they affect water clarity.

Turbidity and total suspended solids refer to particles present in the water column. Turbidity and water clarity are both visual properties of water based on light scattering and attenuation. All three parameters are related to particles in the water column, whether directly or indirectly.

Turbidity is determined by the amount of light scattered off from these particles. While this measurement can then be used to estimate the total dissolved solids concentration, it will not be exact. Turbidity does not include any settled solids or bedload (sediment that “rolls” along the riverbed). In addition, turbidity measurements may be affected by colored dissolved organic matter. While this dissolved matter is not included in TSS measurements, it can cause artificially low turbidity readings as it absorbs light instead of scattering it.

Total suspended solids, on the other hand, are a total quantity measurement of solid material per volume of water. This means that TSS is a specific measurement of all suspended solids, organic and inorganic, by mass. TSS includes settleable solids and is the direct measurement of the total solids present in a water body. As such, TSS can be used to calculate sedimentation rates, while turbidity cannot.

Water clarity is strictly relative to sunlight penetration. While this is usually determined by the amount of suspended solids in water, it can also be affected by CDOM and other dissolved solids. Water clarity is the most subjective measurement of these three parameters, as it is usually determined by human observation.

One of the more common methods of measuring turbidity is with a turbidity sensor such as Turbidity Sensor 4296. Alternatively, measurements can be taken with a handheld and field-ready turbidity sensor or a turbidity meter intended for laboratory benchtop use. These instruments use a light source and one or more detectors to measure the light scattered by particles in water samples.

### 8.1.1 Light Scatter

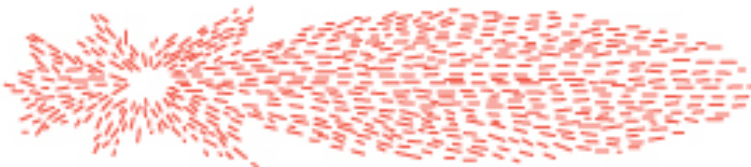
**SMALL PARTICLES**  
SMALLER THAN 1/10 THE WAVELENGTH OF LIGHT  
SYMMETRIC SCATTERING



**MEDIUM PARTICLES**  
APPROXIMATELY 1/4 THE WAVELENGTH OF LIGHT  
SCATTERING CONCENTRATED IN FORWARD DIRECTION



**LARGE PARTICLES**  
LARGER THAN THE WAVELENGTH OF LIGHT  
EXTREME SCATTERING IN FORWARD DIRECTION



The larger a particle is, the more light that will be scattered forward.

Light is scattered and absorbed by particles in the water. Even clear water will have minute light scatter due to the presence of dissolved particles and molecules. This scatter can be in any direction, and the intensity in any given direction is dependent on both the light source and the size of the particle(s). When a particle is much smaller than the beam of light, the scattering is fairly symmetrical in all directions. The larger the particle becomes, however, the more light that will be scattered forward (away from the light beam).

Wavelength also affects light scatter. In general, shorter wavelengths will scatter more than longer wavelengths for the same particle size. Shorter wavelengths are also more susceptible to absorption by colored molecules in the sample. Near-infrared light is rarely absorbed, so dissolved colored material will not affect it. This is one of the reasons that turbidity measurements made through different methods are often not comparable – if the light source is different, the light scatter will be different. While this is accounted for in the calculations, equivalent results are guaranteed.

The distance traveled by scattered light also affects turbidity readings. The longer the light path between the light source and the photodetector, the better the resolution of the instrument at low turbidity levels. The longest path lengths are at 90 and 180 degrees. However, increasing the path length sacrifices measurement range. Both the EPA 180.1 and the ISO 7027 methods limit light path length to 10 cm total. A decreased path length (such as a backscatter-based photodetector) increases the turbidity measurement's upper limit.

However, the more particles present in the sample, the more the light will be scattered. Turbidity meters measure the amount of light scattered at a specific angle and convert that reading into a turbidity measurement.

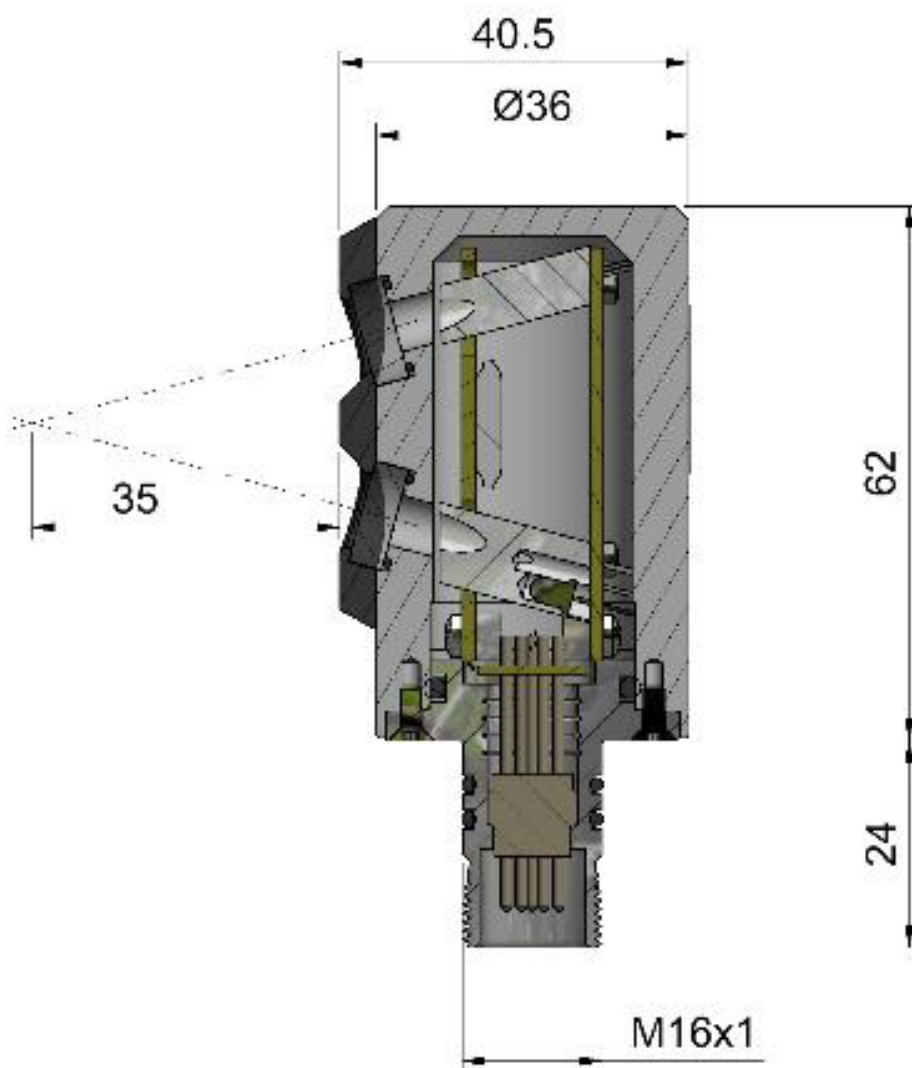


Figure 8-1: Measuring area for Turbidity Sensor 4296

## 8.2 TSS

Total suspended solids (TSS) are the main cause of turbidity. The most accepted method of measuring suspended solids is by weight. To measure TSS, a water sample is filtered, dried, and weighed. This method is the most accurate technique for measuring total suspended solids, however it is also more difficult and time-consuming.

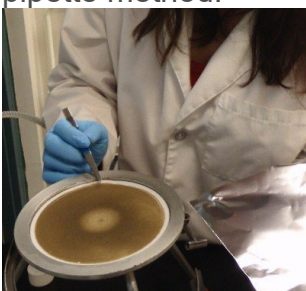
### 8.3 Total Suspended Solids Measurement Methods

Due to the correlations between turbidity and total suspended solids (TSS), turbidity measurements are often substituted for suspended sediment concentrations and TSS measurements. However, when possible, it is more accurate to measure total suspended solids by weight. Turbidity readings can be affected by colored dissolved organic matter (CDOM), while sediment and TSS measurements are not. While the most accurate and accepted method for measuring suspended sediment and TSS is by weighing a sample, the USGS has begun using acoustic Dopplers for in-situ sediment monitoring.

#### 8.3.1 Total Suspended Solids and Suspended Sediment Concentration by Weight

Measured in milligrams per liter of water (mg/L), suspended sediment concentration and total suspended solids readings are based on filtered and dried water samples. TSS encompasses any particles larger than 2 microns in diameter. Any particle smaller than this is considered a dissolved solid.

The main difference between total suspended solids (TSS) and suspended sediment concentration (SSC) is in the amount of water analyzed. After filtering a water sample with a 2-micron filter, the particles are dried and weighed to determine suspended solids. When an entire sample is filtered, dried and weighed, the American Society for Testing of Materials considers the measurement to be the suspended sediment concentration. If a water sample is further subsampled, the subsequent mass measurement will be the TSS measurement. This can be done by shaking/stirring and pouring from the sample bottle (EPA method) or by stirring and collecting a sample with a pipette (APHA method). The EPA method is considered more consistent than the pipette method.



A water sample is filtered, dried, dried and weighed to determine suspended sediment concentrations. Photo Credit USGS

For samples with fine suspended particles (less than 53 microns), the total suspended solids measurement and the suspended sediment concentration will be both precise and accurate relative to the true concentration and each other. However, if larger (medium-coarse) particles are included in the sample, sub-sampling can often introduce error into the TSS measurement. The larger the particle, the more likely that it will not be included in the sub-sample. Coarse sediment, such as sand, is often not included in the TSS measurement. This is due to the rapid settling of larger particles. On the other hand, regardless of particle size, the SSC is usually within 5% of the true particle concentration.

### 8.3.2 Total Suspended Sediment by Acoustic Doppler Measurements

The U.S. Geological Survey has started using acoustic Doppler meters to determine continuous sediment loads estimates. As the Doppler meter pulses sound through the water, the frequency beams will bounce off suspended particles in the water. While these meters are generally used to measure water velocity, the returned beams, known as backscatter, can be used to indicate suspended sediment concentrations. This method requires correction for any sound absorption and beam spread. While it is not as accurate as a TSS mass measurement, and while its performance is still under study, the use of an acoustic Doppler meter opens the door to the possibility of continuous suspended sediment estimates.

## 8.4 FTU versus TSS

Use Aanderaa calculation sheet to enter relation between FTU and Total Suspended Solids (TSS) obtained from water sampling – filtering-drying-weighing.

The sheet calculates new coefficients which can be copied and sent to the sensor for absolute measurements in mg/l

Template is available at

AANDERAA

Template for calculating relationship between Total Suspended Solids (TSS) and Turbidity

DID-060812-02  
03-Nov-21

G2

Turbidity and Total Suspended Solids (TSS) both indicate water clarity. The relationship between these parameters depends heavily on the optical properties of the suspended particles. For conditions where the optical scatters have a fairly constant characteristics it might be useful to establish the relationship between turbidity and TSS. This relationship can then be used for calculating TSS where only Turbidity are available. Standard methods and procedure for acquiring TSS data is given in the US EPA 160.2, APHA 2540D or the European standard NF EN 872.

Collect a set of TSS samples with related turbidity measurements that covers a range as wide as possible (from low to high concentration). Preferably these data should be collected in-situ at the site. Alternatively the data can be obtain by collecting high turbid water in a suitable water container where parallel TSS samples and turbidity measurements can be done. The collect water can then be diluted to obtain lower turbidity/TSS readings/samples. Note that the Turbidity Sensor 4296 require a distance of approximately 0.8 meters to the facing wall in order to achieve optimal accuracy at low turbidity.

The calculation below requires at least 4 points with TSS and turbidity data. A linear regression will be applied producing coefficients to a polynomial with a degree limited to the number of data points minus 2 and maximum 5. The validity of the relationship is strengthened by entering a higher number of data points.

	Turbidity Reading (FTU)	TSS (mg/l)
Point 1	--	2,6
Point 2	2,0	3,5
Point 3	3,0	4,2
Point 4	3,9	4,9
Point 5	4,9	5,4
Point 6	5,8	5,9
Point 7	6,8	6,4
Point 8	7,7	6,8
Point 9	8,7	7,2
Point 10	9,6	7,6
Point 11	10,6	8,0
Point 12		
Point 13		
Point 14		
Point 15		
Point 16		
Point 17		
Point 18		
Point 19		
Point 20		

Polynomial Degree

2

Index	0	1	2	3	4	5
TSSCoef	1,757510E+00	8,838081E-01	-2,867933E-02	0,000000E+00	0,000000E+00	0,000000E+00
Text	Set Passkey(1000) Set TSSCoef(0,000002E+00,8,838081E-07,-0,286793E-07,0,000000E+00,0,000000E+00,0,000000E+00)					
Commands	Save					

Show Extrapolation (%)

30

Fit Deviation (mg/l)		
Standard dev.	Maximum	Minimum
0,06	0,13	-0,09

Figure 8-2: Template for calculating relationship between TSS and FTU

## CHAPTER 9 Electro Magnetic Compatibility

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For a manufacturer to legally produce and sell a product, it must apply for CE marking. This means that the commercialized product is conform to the CE applicable standards and can freely circulate within the EFTA (European Free Trade Association) & European Union countries. The applicable directive for the Turbidity products is the EU EMC 89/336/EMC (all electrical and electronic appliances) which mainly focus on the electromagnetic disturbances the sensor can generate, which should not exceed a level allowing radio and telecommunication equipment to operate as intended, and that the sensor has an adequate level of intrinsic immunity to electromagnetic disturbance to be able to operate as intended. This chapter describes the requirements for the Electromagnetic Compatibility (EMC) of the sensor; EMC filter and protection solutions can be required if used stand-alone.

### 9.1 EMC Testing

The Turbidity sensor has been tested at an accredited test laboratory to verify that the sensor fulfils the requirements in the EU EMC directive (89/336/EMC).

#### *Applied standards*

- EN55011 (2009)+A1
- EN 61326-1 (2013)

#### *Applied tests*

- Conducted Emissions
- Electrostatic Discharge Immunity
- Surge Immunity
- Conducted RF Disturbance Immunity

Other tests were found as not relevant to this sensor due to underwater use and DC power.

### 9.2 Cables

Different cables are available for stand-alone use with free end and connectors. The cables have both power and signal lines (RS-232/RS-422). Contact factory for more information on cables that is best suited for use in the actual application. When delivered, system drawings/cable drawings give details on parts connection and installation overview with best EMC performance (best noise and surge immunity).

### 9.3 Power – Voltage range

The input voltage range is from 6 to 14Vdc. When using long cables the voltage should be as close to 14V as possible.

## CHAPTER 10 Documents and Accessories

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In this section we show examples of sensor specific documentations that normally follow the sensor. You will also find description of cables that are normally used with the sensor.

### 10.1 Example of Test & Specifications sheet and Certificates

In this section we show samples of what documents included on the memory stick following the sensor. All calibration data are stored in the sensor so these certificates is only used to prove the accuracy of the sensor and to document that testing and calibration are done following the standard procedure. If your sensor has been back for calibration or maintenance, please make sure that you also update your archive.

If you need a new certificate for one of your sensors please contact [support.aanderaa@xylem.com](mailto:support.aanderaa@xylem.com)

- Operation Manual
- Data Sheet
- Test & Spec. Sheet
- Calibration Certificate Temperature
- Calibration Certificate Turbidity






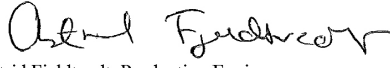
 <b>TEST &amp; SPECIFICATIONS</b>	
Form No. 992, January 2021	
<b>Product:</b> Turbidity Sensor 4296A	
<b>Serial No:</b> 35	
<hr/>	
<b>1. Visual and Mechanical Checks:</b>	
1.1. Soldering quality	<input checked="" type="checkbox"/>
1.2. Visual surface	<input checked="" type="checkbox"/>
1.3. Galvanic isolation between housing and electronics	<input checked="" type="checkbox"/>
<b>2. Current Drain and Voltages:</b>	
2.1. RS232 average current drain at 0.5Hz sampling (max: 24mA)	19.0 mA
2.2. RS422 average current drain at 0.5Hz sampling (max: 25mA)	NA mA
2.3. RS232 peak current drain at 0.5Hz sampling (max. 100mA)	48 mA
2.4. RS232 quiescent current drain (max: 150µA)	77 µA
2.5. RS422 quiescent current drain (max: 150µA)	NA µA
2.6. AiCaP average current drain at 0.5Hz sampling (max: 20mA)	14.0 mA
2.7. AiCaP quiescent current drain (max: 150µA)	73 µA
2.8. DSP voltage, (3.3 ±0.15V)	3.29 V
2.9. DSP core voltage,(1.8 ±0.05V)	1.80 V
2.10. Excitation driver voltage, (4.6 ±0.15V)	4.50 V
<b>3. Electronic performance test:</b>	
3.1. C1Amp at zero reflectance, range 1 (<400mV)	NA mV
3.2. C1Amp at zero reflectance, range 2 (<400mV)	22 mV
3.3. C1Amp at zero reflectance, range 3 (<400mV)	NA mV
3.4. C1Amp at zero reflectance, range 4 (<400mV)	NA mV
3.5. C1Amp in 25 FTU jig and range 1 (1000 to 2000mV)	NA mV
3.6. C1Amp in 125 FTU jig and range 2 (1000 to 2500mV)	2237 mV
3.7. C1Amp in 500 FTU jig and range 3 (1000 to 2000mV)	NA mV
3.8. C1Amp in 2500 FTU jig and range 4 (800 to 1500mV)	NA mV
3.9. C2Amp at room temperature (1500 to 2500mV)	NA mV
3.10. RawTemp at room temperature (-100 to 200 mV)	NA mV
<b>4. Temperature cycling test:</b>	
4.1. TXCAmp temperature drift over 0-50°C, range 1 (<120mV)	NA mV
4.2. TXCAmp temperature drift over 0-50°C, range 2 (<120mV)	116 mV
4.3. TXCAmp temperature drift over 0-50°C, range 3 (<120mV)	NA mV
4.4. TXCAmp temperature drift over 0-50°C, range 4 (<120mV)	NA mV
4.5. RawTemp minimum over 0-50°C, range 4 (-600 to 200mV)	-231 mV
4.6. RawTemp maximum over 0-50°C, range 4 (200 to 900mV)	743 mV
Date: 21 Sep 2021	
Sign:	
 Astrid Fjeldtvedt, Production Engineer	

Figure 10-1: Example of Test and Specification sheet



**Figure 10-3: Example of Turbidity Calibration Certificate**



# CALIBRATION CERTIFICATE

Form No 993, January.2021

Certificate no: Turbidity Sensor 4296\_35\_187708  
 Range: 0-25 FTU

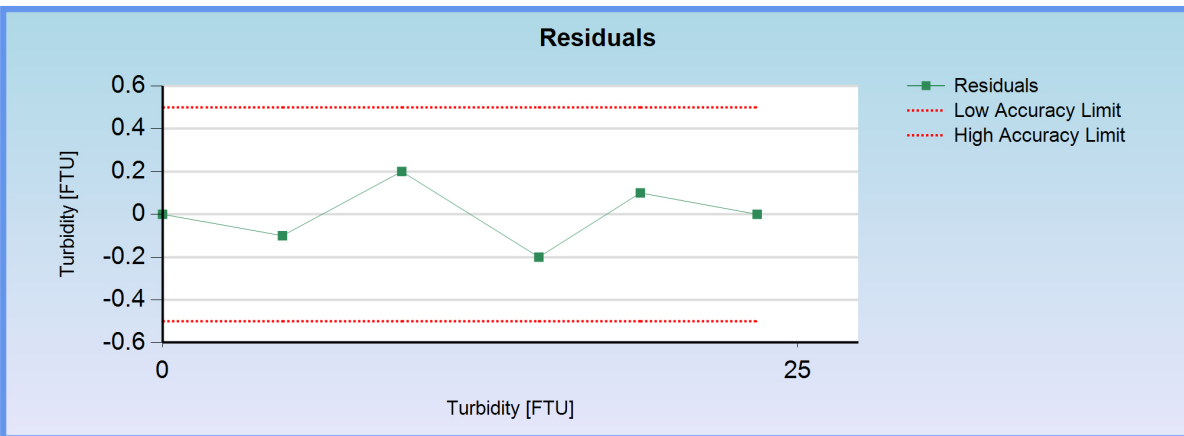
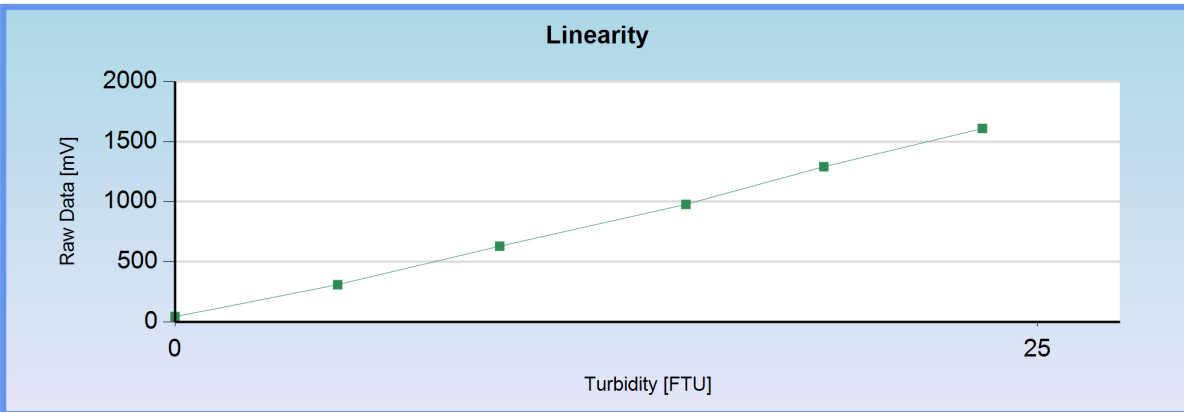
Product: **Turbidity Sensor 4296**  
 Serial no: 35  
 Calibration date: 02.09.2021

This is to certify that this product has been calibrated and verified using the following reference equipment:

Reference Equipment	Serial
Hach .....	96060000235

Calibration Points	0	1	2	3	4	5
Turbidity Reference[FTU])	0.0	4.7	9.4	14.8	18.8	23.4
Raw Data (TXCAmp)[mV]	43.3	309.4	629.6	977.7	1291.3	1609.4

**Calibration result:**



Calibration Coefficients	0	1	2	3	4	5
C1R2Coef	0.000000E+00	0.000000E+00	-7.756828E-01	1.851977E-02	-3.917050E-06	1.076620E-09

Date:02.09.2021

*J. Hovdenes*  
 Jostein Hovdenes, Product Manager, Sensors



### **10.1.1 AADI Real-Time Collector connection with Windows 10**

Please contact [aanderaa.support@xylem.com](mailto:aanderaa.support@xylem.com) for assistance.

## 10.2 Connecting Cables

Aanderaa offers a wide range of standard cables;

### 10.2.1 Set-up and configuration cable 3855.

Set-up and configuration cable 3855 are designed for laboratory use only. The cable is used to configure a sensor using either AADI Real-Time Collector or a Terminal software such as Terra Term. If you don't have any COM ports on your computer I can be used in combination with a RS-232 to USB converter such as Tripp-lite Keyspan Model USA -19HS. The sensor can either be powered from a USB port or using a power supply connected to the USB extension cable.

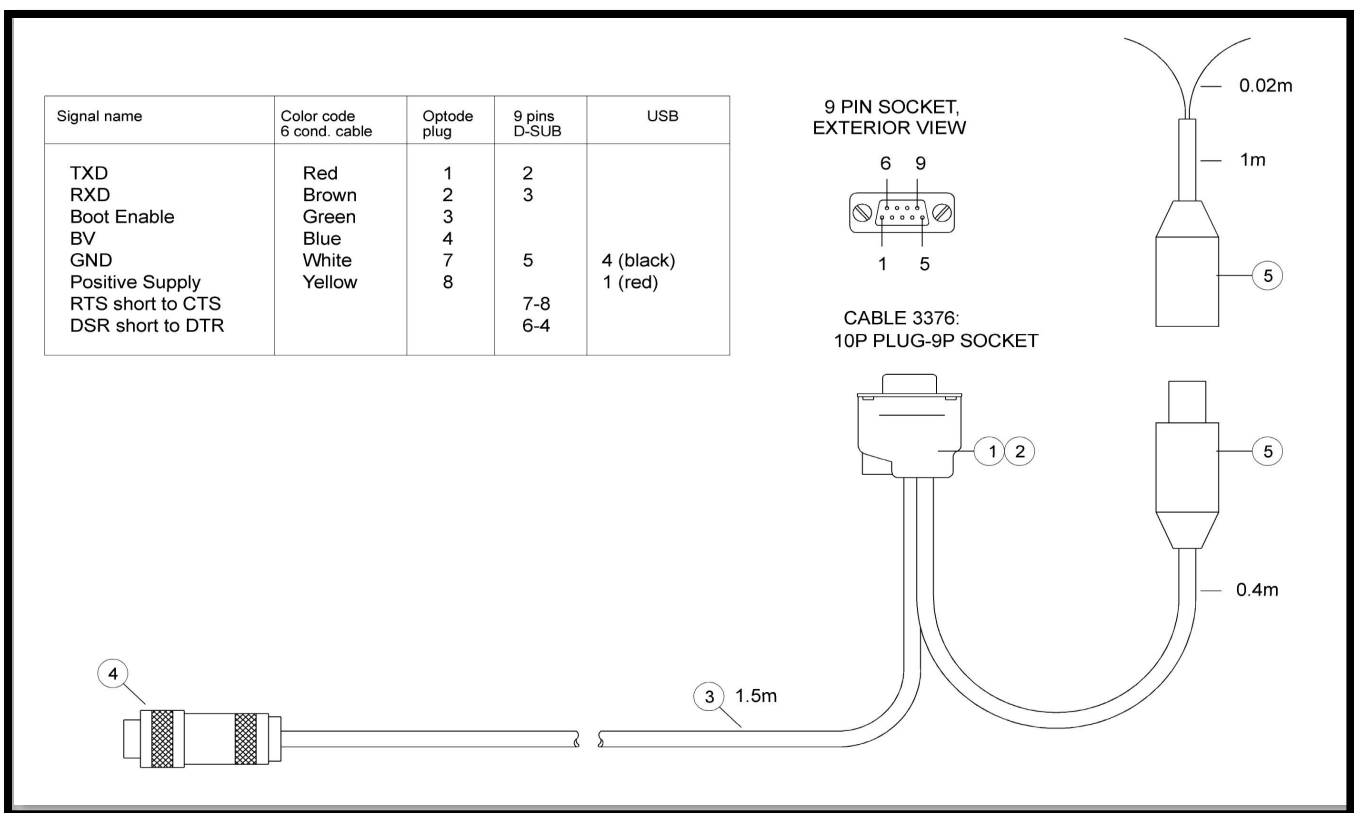


Figure 10-4: Set-up and configuration cable 3855

### 10.2.2 Set-up and configuration cable 4865.

Set-up and configuration cable 4865 are like the previous 3855 cable but with a watertight SP plug for use in field. The cable is used to configure a sensor using either AADI Real-Time Collector or a Terminal software such as Terra Term. If you don't have any COM ports on your computer I can be used in combination with a RS-232 to USB converter such as Tripp-lite Keyspan Model USA - 19HS. The sensor can either be powered from a USB port or using a power supply connected to the USB extension cable. The cable can also be used for deployments with real-time data to a computer or a logger.

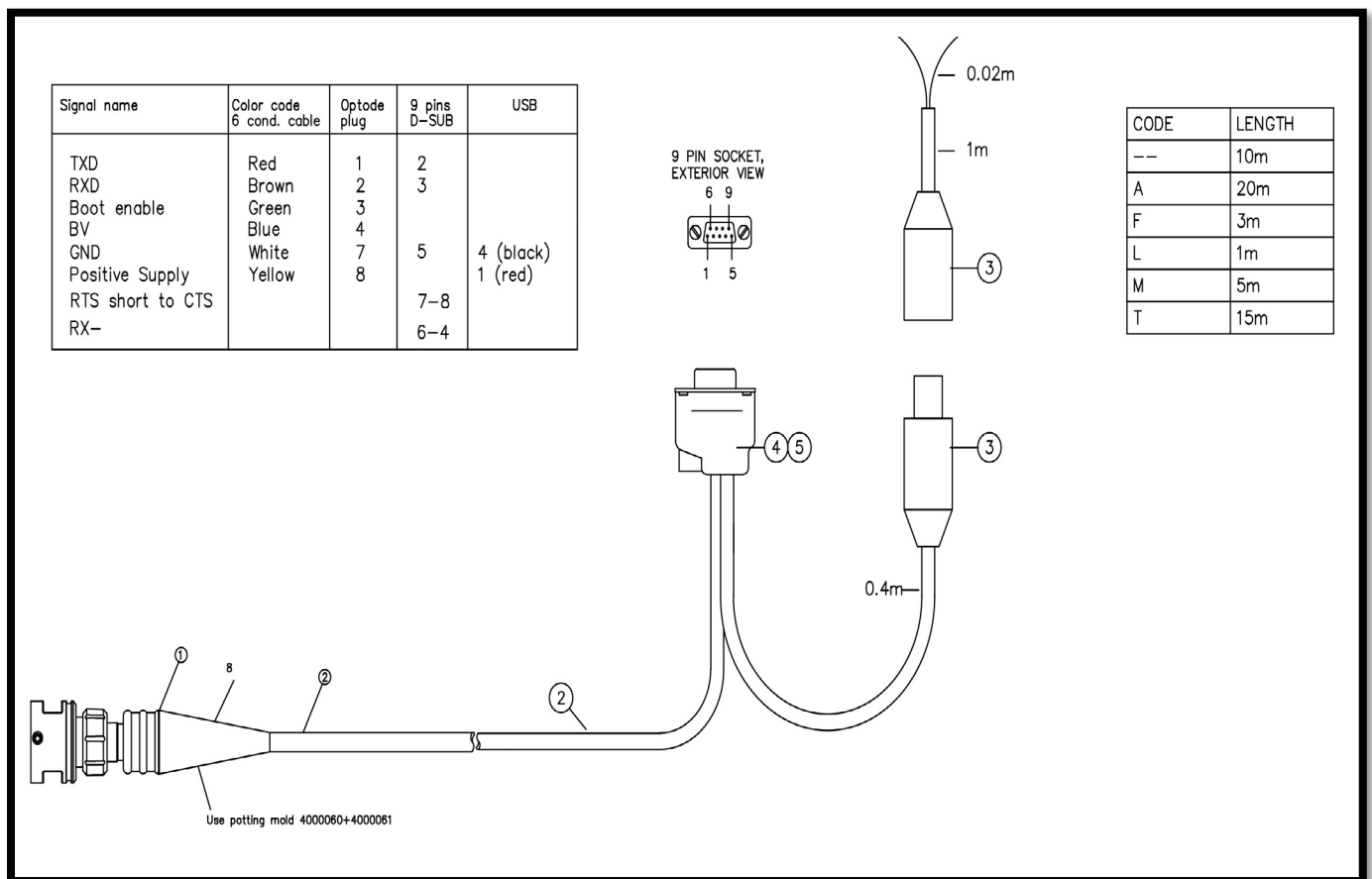


Figure 10-5: Set-up and configuration cable 4865



### 10.2.3 Free end cable 4762

Free end cable 4762 is designed for use with RS-232 output. Please make sure that the cable is terminated properly before power is switched on. Please also note that the lemo plugs are not 1 to 1 but 1 to 8. This means that pin 1 on the sensor is connected to pin 8 on the cable etc.

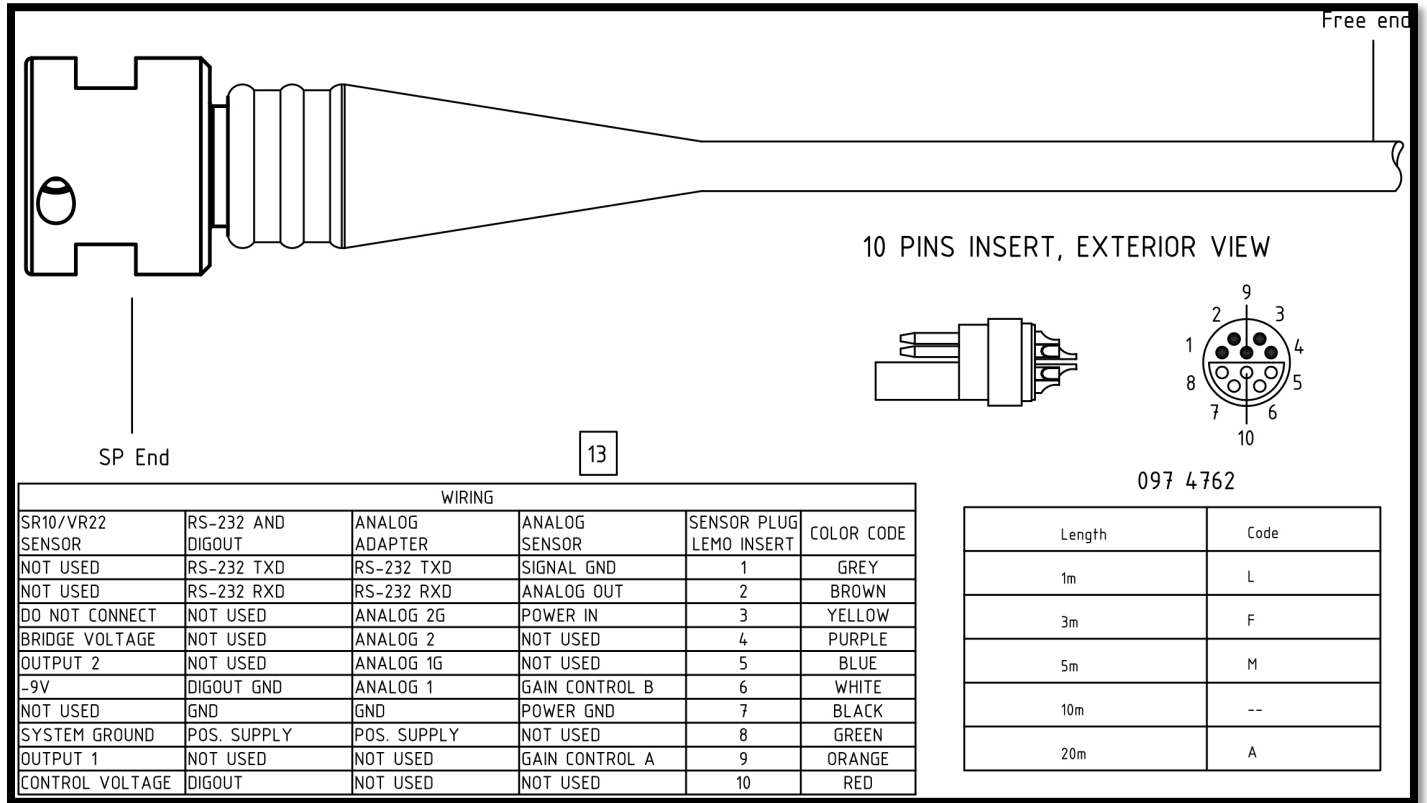


Figure 10-6: Free end cable 4762

### 10.2.4 Remote cable 4793 for connecting sensor to SeaGuard/SeaGuardII

Remote cable 4793 is used when you want do mount the sensor away from the instrument top-end plate. This is used if you want to measure gradients and one sensor is located on the top end plate and the second sensor are mounted in the water column away from the instruments.

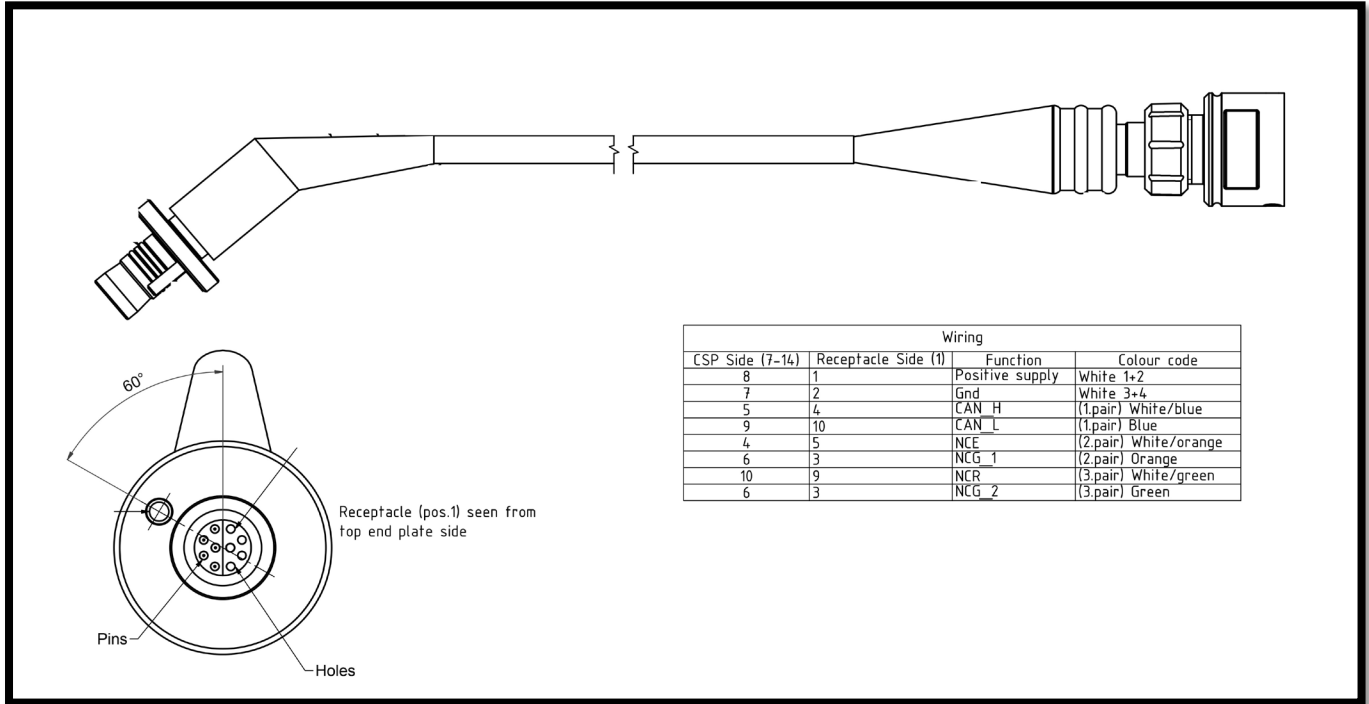


Figure 10-7: Remote sensor cable 4973

### 10.2.5 Patch cable 4999

Patch cable 4999 are used if sensor is mounted in position 6 on the top-end plate or if the instrument is without a hub-card, then the patch cable are used to connect the sensor to the instrument main board.

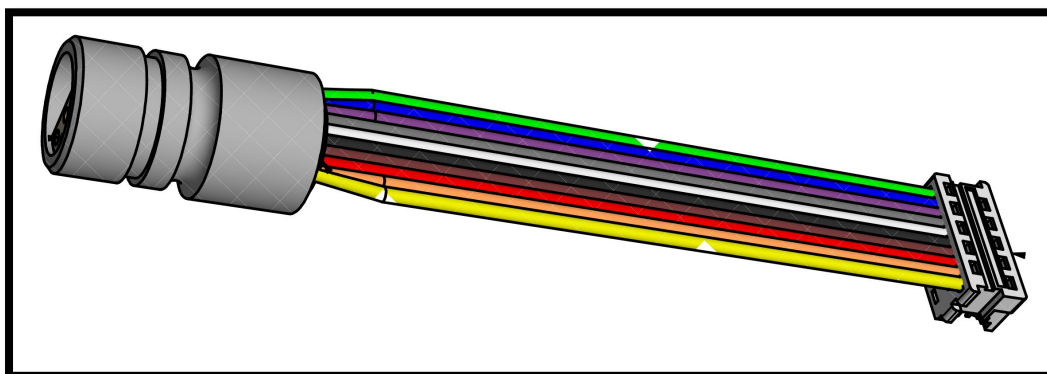
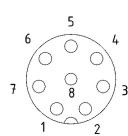
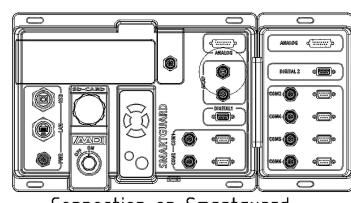


Figure 10-8: Patch cable 4999

### 10.2.6 Cable 5236 for connection to SmartGuard using AiCaP

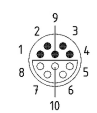
8pin M12 plug, EXTERIOR VIEW



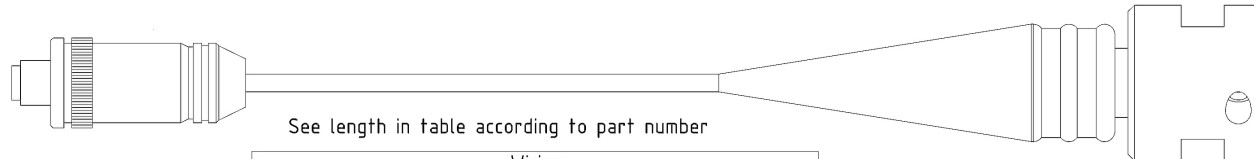


Connection on Smartguard

10 PIN INSERT, EXTERIOR VIEW



0975236 Length	
M	5m
-	10m
A	20m
D	50m



See length in table according to part number

Wiring			
Signal Name	8pin M12 plug	Cable colour	10p LEMO CSP
CAN_L	1	White	9
NCG1/PWR_Ret	2	Pink	6
NCR	3	Green	10
PWR_Out	4	Red	8
PWR_Ref	5	Blue	7
NCG2/PWR_Ret	6	Yellow	6
CAN_H	7	Brown	5
NCE	8	Grey	4

Terminate pin 9 and 5 with 120Ω resistor

## Xylem |'zīləm|

- 1) The tissue in plants that brings water upward from the roots;
- 2) a leading global water technology company.

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**For more information on how Xylem can help you, go to [www.xylem.com](http://www.xylem.com)**



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